



GROW MORE VEGETABLES AND EAT MORE VEGETABLES

BY

RAI D. N. MITRA BAHADUR

(Deputy Development Commissioner, Bengal)

Revised and Enlarged

BY

Prof. P. K. BOSE

Formerly Pro-Vice-Chancellor for Academic Affairs

&

*Head of the Department of Statistics,
Calcutta University*

AND

Prof. B. B. ROY

*Formerly Head of the Department of Agriculture,
Calcutta University*



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FOREWORD

'Grow More Vegetables and Eat More Vegetables' by Late D. N. Mitra was published by the Calcutta University about four decades ago. Since then agriculture in India has made significant progress. The old publication has been thoroughly revised incorporating new ideas as far as possible. I hope this volume will be useful both to the Students and to the interested public. In this work besides Prof. B. B. Roy, Dr. B. Bhattacharya of the Faculty of Agriculture, Calcutta University, took keen interest and scrutinised even minor details. But for them it would have been impossible to publish this book.

Sri Arun Ray, Pro-Vice-Chancellor, (Business Affairs and Finance) of the Calcutta University, made all arrangements for the publication of this book. For this assistance I am really grateful. I offer my sincere thanks to Sri A. M. Ray, Superintendent, Calcutta University Press, for the speedy publication of this book, to M/s. Sutton and Company for supplying the beautiful blocks, and to Sri R. N. Mitra for reading the proofs.

Calcutta University

10.4.'80

P. K. Bose



DEBENDRA NATH MITRA

Sri Debendra Nath Mitra (Rai Bahadur) was born at Antpur in Hooghly on the 29th October, 1889. Sri Mitra had his general education at the Hindu School and the St. Xavier's College and later was admitted to the Sabor Agricultural College. Coming out successfully from the Sabor Agricultural College he joined the Agricultural Department of the government of the undivided Bengal. Initially he was posted in the Govt. Agricultural Farm at Faridpur now in Bangladesh. Since the very start of his official career Mr. Mitra devoted himself heart and soul to the spread and improvement of agriculture and actually initiated a movement for attracting the educated middle class youth to this sector of economy. To popularise agriculture and provide encouragement to the cultivators he organised agricultural exhibitions in the farm at Faridpur which was visited by both official and non-official stalwarts viz. the British Governor of the province and national leaders of the stature of Mahatma Gandhi, Subhas Chandra Bose and others.

Acharya P. C. Roy took personal interest in the schemes and programmes drawn by him for the propagation of agriculture among the job-hungry Bengali youths. Having served the Agricultural Department in various capacities for 30 years Sri Mitra retired as Deputy Development Commissioner in 1945. But as agriculture was in his blood, he could not live a secluded life. From the field he now turned to the press. He himself started and edited a fortnightly paper devoted exclusively to agriculture where he published a large number of articles based on his life-long experience in the field of agriculture and he also suggested some methods for increasing crop-yield which the post-independent state government valued much. Sri Mitra was the author of a number of books and treatises in both English and Bengali dealing with agriculture. Also he contributed articles to the press on his own subjects. The present volume was written under the shadow of the great famine of 1943 ; it was meant for drawing attention of the people to agriculture. In recognition of his knowledge and experience he was made member of various boards, committees etc., viz., West Bengal Board of Secondary Education, Faculty of Agriculture, Calcutta University etc. Sri Debendra Nath Mitra was a man of rare quality. He died in Calcutta on the 14th January, 1972.

P. K. BOSE



CHAPTER I

Suitable site : Laying out : Suitable soil : Tillage : Manuring of soil : Water supply : Injurious insects and diseases : Rotation.

Suitable site :

Low lying tracts do not afford suitable sites for a vegetable garden, the soil being unduly heavy and moist, preventing early sowing and ploughing so essential for production of early crops. Vegetables cannot also stand water-logging. The land should therefore be high and well drained. It should also be open and no big tree should be near by to shade the land. A south eastern aspect is preferable. The land should be fenced off by a good hedge serving both as screen and protection. A good supply of water is an essential point for successful cultivation of vegetable, and proximity to water is therefore a chief consideration for a site of vegetable garden.

Laying out :

The laying out of the land should preferably be in the shape of a square or rectangle which should be divided into plots or beds, with narrow paths in between, along which water channels may be run. Each plot or bed should be of convenient size according to the area and size of the land, and should be well-levelled for even distribution of irrigation water. Ridges and furrows may also be made at suitable distance 45, 60, 75 or 90 cm. apart for planting such crops as tomatoes, brinjals etc. on the ridges with irrigation in the furrows. Basins may also be prepared at required distance 1, 1.5 or 2 metres apart for planting gourds, cucumber etc.

Suitable soil :

A soil is normally composed of small rock fragments and minerals of various kinds. The rock fragments are the remnants of rock from which the soil has been formed. They are usually coarse. The minerals, on the other hand, are highly variable in size. Sometime more of the bigger size sand particles are present, sometime intermediate silt predominates, and in other very fine size clay abounds. Depending on the proportion of these particles, therefore, a soil may be sandy, loamy, silty or clayey. A sandy soil is loose, porous and well drained but cannot



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retain moisture and so quickly dried up. A clayey soil, on the other hand, is hard when dry, sticky when wet and has high water holding capacity. Its drainage, however, is imperfect. A loamy soil which is neither very loose nor very stiff and hard is the most desirable for growing vegetables.

All soils have some proportion of organic matter or humus. This is a desirable part of the soil, since it largely helps the soil to be friable and productive. Every effort should, therefore, be made for increasing the humus content of the soil.

In plant growth the soil plays an important role, namely (i) it serves as a foot-hold or anchorage, (ii) it provides a suitable environment for the growth of the plant and (iii) it is a store house of plant food.

Below the top 15 to 30cm. of surface soil lies the subsoil. It represents more nearly the original soil since it is unattached by cultivation or manuring of the surface soil. It is much poorer in plant nutrient than the surface soil, and there is no advantage, but distinct disadvantage in bringing it to the surface. The subsoil may be improved by growing deep rooting crops which open the subsoil, increase its store of organic matter and effect a certain transference of plant-food to the surface.

At least the top 45 to 60cm. of soil should be well-dug, thoroughly worked and manured before the seeds are sown or seedlings are transplanted. The actual depth will of course depend on the extent of the top soil, since it is undesirable to bring the raw subsoil to the surface.

Tillage :

The word "tillage" is applied to the different methods of working the soil in order to secure the conditions needful for healthy growth of crops. By properly stirring up the surface soil and intermixed with fresh air many chemical changes take place in that part of the soil and much of the plant-food is released. In fact, an adequate tillage is necessary to enable a soil to function properly. Generally speaking, the chief objectives which tillage aims to secure are :

1. To develop uniformity of soil conditions suitable for sowing of seeds and setting of plant.
2. To hasten and augment physical and chemical actions in the soil which are helpful for plant growth.
3. To aid in the saving of soil moisture and to provide necessary aeration.



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4. To destroy and prevent the growth of weeds or other vegetation not desired on the soil, and to destroy insects with their nests and other parasites which are harmful to crops.

5. To remove stubbles or other residues of the previous crops, or incorporate these into the soil.

Tillage is done by three classes of implements :

i) By deep working implements like ploughs, spades etc. These are used for breaking up soils.

ii) By surface working implements like hoes, khurpis, spades, harrows, ladders etc. These are used to pulverise the surface soil, stir for aeration and conservation of moisture, prepare the surface-soil for reception of seeds, to cover the seed, to destroy weeds, earth up growing plants, spread manures and prepare furrows.

iii) By compacting implements like rollers, beams etc. The objects of using them are to crush and pulverise the surface soil by breaking clods, level the surface soil, cover the seeds after sowing and conserve soil moisture.

Great care should therefore be attached to tillage while preparing the soil in all its stages and even while the crops are growing. It should always be remembered that the garden should be continuously hoed to keep the plots clean of weeds and free of insects and to aerate the soil. Manuring and watering are no doubt essential for the success of vegetable cultivation but it is worth while remembering that without adequate soil working even copious application of manure and water will not be of much avail; on the other hand, proper soil working will minimise the application of manure and water.

Manuring of soil :

It should be borne in mind that the productivity of soil of a vegetable garden has always to be taxed to the utmost to obtain a succession of various vegetables suitable for each season of the year, and it implies abundant manuring. To take much off and to put little in, is like continuously drawing money from a bank account without depositing anything.

Farmyard manure is ideal for vegetable growing. The role of application may be 2 quintals for an area of 1,000 sq. metres. Leaf mould is also a very valuable manure for vegetable. It is specially useful for seed-beds. A constant supply of decayed leaf mould may be arranged on the spot by sweeping up leaves and mixing with soil. In due time the leaves will decay and make good potting soil.



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Manures should be applied after the land is prepared and should be thoroughly mixed with the soil. It is essential that the manure should be well decomposed.

Chemical fertilizers are as effective as farmyard manure. These are available in the market and may be purchased as required. There may be simple fertilizer (like sulphate of ammonia, urea, super-phosphate etc.) or may be mixed fertilizer like diammonium phosphate containing both nitrogen and phosphorus nutrients. A short note on manures and fertilizers given in the Appendix will be useful.

Green manuring may also be practised. This consists of sowing a quick growing leguminous crop and ploughing it into the land or incorporating it into the soil by digging it in. Compost also may be prepared out of all waste vegetable matter. Method of its preparation is given in the Appendix.

Water Supply

As mentioned above successful vegetable cultivation is only possible when there is abundant supply of irrigation water. The amount of water required depends on the soil type, crop to be grown, prevailing weather condition, quality of tillage and also on the application of fertilizer and manures. Irrigation should be in thorough without being too frequent but given as required according to the condition of the soil.

A practical tip to remember is that an adequate irrigation should be such that it will permit hoeing or stirring with a khurpi after 24 hours in the hot weather and after 48 hours in the cold weather. After each watering the surface soil should be loosened and pulverised and weed removed in the process.

Injurious insects and diseases :

Insects cause considerable damage to vegetables. They are always at work in all parts of the plant, root, stem, foliage, blossom and seed. The roots are attacked by various ground insects which grow away at the surface of the roots, cut them in sunder or tunnel into them; others produce galls or deformities on them, and so stunt the growth. The stems are attacked by biting insects and are tunnelled into, or may be damaged by sucking insects. The foliage is attacked by other many insects and stripped and mined into and blistered, or it may be killed by the loss of the sap. Seedlings are killed by beetles which cut off the seedling just below the seed leaves (cotyledon), or so riddle the young leaves of the plants etc. Blossom

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is also attacked by some insects, and the seed is damaged by others which harbour in it.

"One penny worth of prevention is worth a pound of cure" should be the maxim in the matter of checking the spread of insect attacks. The following recommendations are worth remembering.

(i) A strong healthy crop should always be grown, as it has the power of resisting the attacks of insects.

(ii) Weeds should be destroyed by clean cultivation, as it will diminish the number of host plants available for the insects. There should not also be weeds and grasses around the vegetable plots.

(iii) Heaps of rubbish afford good hiding places and abodes for many insects. They should be removed from the plots. Similarly, manure pits or heaps are favourite breeding places for insects, and care should be taken to see that they are not very close to the garden.

(iv) Stray plants of any crop should never be allowed to remain in the plots after the harvest of the main crop. Nor should any crop be allowed to throw up fresh shoots after harvest, as they provide a home and food supply for insects when nothing else is available.

(v) Rotation of crops reduces the attacks of destructive insects.

(vi) The land should be ploughed well in summer, as it will kill eggs and pupae of many insects by exposing them to the sun.

(vii) The soil may be consolidated by laddering to make it difficult for insects to get in and get out of it.

(viii) Genuine and pure seeds free from any insect attack should always be used.

(ix) A careful watch should always be kept for the first appearance of insects, and their spread may be checked by judicious and timely hand picking.

A general knowledge of the life-history of insects and of some common remedies to combat them may suggest what is to be done, and the right time for doing it, so that by following simple treatments, they may be destroyed. A short note on it has, therefore, been given in the Appendix.

Many of our garden crops are liable to the attacks of diseases caused by fungus, bacteria and virus. Fungus diseases are propagated very rapidly by dust-like particles, called spores, which float in air and settle on the plant where they grow. In some cases, it is possible to cure the disease but in others, preventive measures may be used with partial or entire success. The latter is preferable. In fact, the proverb, "prevention is better than cure" should be the slogan in dealing with crop diseases. An application of a preparation called bordeaux mixture or



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Burgundino mixture (See Appendix), or several fungicide preparations from well known manufactures are very useful to prevent all types of fungal diseases.

Plants raised from robust parent stocks grown in suitable soils and under favourable conditions are however less liable to diseases than seedlings from feeble parents, or those which have been rendered weak and sickly by deficiencies in the soil or faulty cultivation. It should, therefore, be remembered that disease generally begins with unhealthy specimens, and these form centres of contamination from which the mischief spreads. It is thus very important that seeds from healthy stocks should be sown, and that a vigorous constitution should be developed by good cultivation.

The attack of bacteria and virus kills the plant entirely in a short time. They are very difficult to control. The common remedy is to uproot a diseased plant and to burn it completely. As in the case of insects, the following general instructions may be helpful in dealing with the diseases of plants :

(i) Seeds before sowing should be treated with some disinfectants made from organic mercury compound, (ethyl mercury phosphate, ethyl mercury chloride, chlorophenol mercury), copper compounds (copper carbonate, copper oxide), or non-metallic organic compounds (tetrachloro-p-benzoguinone, tetramethylthiuram disulphide) or any other similar chemicals manufactured by reputed dealers. In dealing with seeds which carries infection internally, hot water treatment (54 for 10 minutes) is most effective.

(ii) Dustings and sprayings of standard fungicides on the plants prevent the attack as well as the spread of all diseases.

(iii) Plants or plant parts attacked with diseases should be removed and burnt.

(iv) Weeds, jungles, etc. must not remain in the plots or near about.

(v) Crowding of seedlings should be avoided.

(vi) Rotation of crops should be followed.

(vii) Clean cultivation and clean surroundings are strongly recommended.

(viii) Seeds from healthy stocks should be sown.

(ix) Vigorous constitution of crops should be developed by good cultivation.

Rotation :

Rotation of crops is strongly recommended. Different groups of familiar plants differ from each other in their root characters and in

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amount and nature of the food materials they take up from the soil. One crop repeatedly grown on the same land tends, therefore, to cause an earlier exhaustion of the nutrients from the soil, while the demand for plant nutrients is also confined to that section of the soil in which the crop develops its roots. Also frequent repetition of a crop on the same land tends to encourage the development of diseases and insects pests special to it, which prey on and may ultimately destroy it. The alteration of crops of varying root characters and development, thus enables the resources of the soil to be more judiciously utilized, and prevents its exhaustion from the same layer of surface soil. A systematic rotation thus assists materially in reducing the attacks of insects pests and diseases, and also prevents the accumulation of injurious secretions in the soil from plants of the same family continually grown on the same plot. Again, in the system of rotation the growth of one kind of crop is made advantageous to another, immediately succeeding, either through its effect in cleaning the land, in ensuring adequate tillage, or enriching it in nitrogen derived from the atmosphere. Generally speaking, rotation therefore serves the following purposes :—

- (a) It enables plants to make more equal and uniform use of the plant nutrients present in the soil.
- (b) It saves them from serious attacks of insects, and fungus.
- (c) It is economical in the use of manures and fertilizers.
- (d) It keeps the soil much cleaner thereby raising its fertility.
- (e) It reduces the cost of labour.

In preparing a programme of rotation, the following should be borne in mind :—

- (a) Crops of the same natural order should not follow one another too freely.
- (b) Deep-rooted crops should be followed by shallow-rooted crops.
- (c) Leguminous crops should find a place in every rotation.

Though it is found beneficial to practise some system of changing or rotating crops, owing to the small area of which vegetable gardens generally consist, and to the large variety of crops that are to be usually grown, it is almost impossible to practise any definite system of rotation. The most that can be done or aimed at is to group the various kinds of vegetables and in this way change the position of each group annually. In order to enable the readers to follow a system of rotation as far as possible, natural orders of the vegetables have been mentioned in the Appendix.

Lastly, in practical work there is nothing like method. Crop the land systematically. Constantly forecast the future work and the disposition of the ground for various crops, keeping in mind the propor-



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tions they should bear to each other. Sowing or planting in lines at the proper distances apart is the best. When crops are in lines, they can be efficiently thinned, weeded and hoed—in other words they can be cultivated.



CHAPTER II

Seeds : Seed-beds : Sowing in seed-beds : Seedlings : Transplantation of Seedlings.

Seeds -

For complete success in vegetable cultivation good seed is the main and foremost requirement. Seeds are considered as good when they are (i) free from impurities, (ii) viable, (iii) free from diseases and (iv) true to the type. As seed production is a highly specialized job requiring particular knowledge and skill not possessed by all vegetable growers, it is always advisable to buy seeds from reliable dealers having a good reputation in the locality.

The vegetable seeds loose their viability rapidly and do not germinate satisfactorily if they are not stored properly. Moisture content of the seed and the storage temperature are the two most important factors to be remembered. Dry the seeds thoroughly in sun before storage and keep the dried seeds in air-tight containers in a cool dry place. Treating the seeds with insecticides before storage will eliminate the possibility of insect damage during storage. The vegetable seed growers often disinfect seed with fumigant like carbon disulphide or mix the seeds with little DDT or BHC and store the seeds in a air-tight container for the next season. Expose to damp atmosphere generally deteriorates the viability of seed quite rapidly. Under good storage condition many vegetable seeds may be preserved for more than a year except onion and parsnip. Tomato, brinjal, pumkin, lettuce, spinach, turnip, muskmelon, watermelon, cole crop seed may be preserved in viable condition for more than four years. Similarly, carrots, peas, radish, beet seeds etc. may be preserved for three years but bhindi, pipper, bean seeds cannot be stored for more than two years. Old seed, however, be sown after test of germination percentage.

Seeds of certain vegetables e.g. cabbage, cauliflowers, tomato, potato, etc. are obtainable in there strains, early, mid-season and late. To obtain a regular succession of vegetables, all these three strains may be sown one after another. The most important point is to sow the right variety of the seed at the right time, and for this the advice of the seed dealers with regard to the time of sowing of each variety should always be obtained and followed.

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Seed-beds :

There are some crops, the seeds of which are sown direct in the soil in which they grow upto the harvest, but there are others, the seeds of which are to be sown in the seed-beds first and then the seedlings are transferred to the site of growing till harvest. In order to ensure proper germination of the seeds and to make the seedlings healthy and strong, great care should be taken in the preparation of the seed-beds. It will be worthwhile to remember the following instructions :

(i) Seed-bed should be raised, well drained and it should be in a sunny situation. The surface soil should be dry, 24—30cm. deep and be prepared to a fine tilth, free from weeds, undecomposed crop residues extraneous materials. The soil should be mixed up with enough quantity and other of leaf mould or far m-y ard-manure. The general fertility statusthe of soil should be high enough to ensure proper supply of food material to the young plants.

(ii) The seed-bed may be made of three layers—in the first layer (5 cm) broken bricks may be spread, in the second (10 cm) loose clay soil and sand in equal proportions, and in the third and top layer (7.5 cm) 1/2 part garden soil and 1/2 part leaf mould, thoroughly mixed together.

(iii) The width of the seed-bed should not be more than one meter so that it may be worked up from one side.

Sowing of Seeds and after-care :

(i) Sow seeds by instalments for succession of crops as mentioned before.

(ii) Always avoid sowing of seeds too deep in soil. Depth of sowing usually depends on the size of seeds—the smaller the seeds shallower should be the depth of sowing.

(iii) Very fine seeds should be mixed with fine dry sand to make sowing more uniform and certain.

(iv) Sowing should be as far as possible, preferably in lines, about 10 cm. apart. Too thick sowing should always be avoided, as this will produce weak, legy seedlings.

(v) After sowing the seeds in seed-beds they should be covered with thin layer of very loose soil which should be pressed gently by hand.

(vi) Water gently with a fine rose can to keep the soil just moist and at the same time avoid washing away of the covering soil



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during watering. Too much moisture in the seed-bed causes rolling of seeds and seedlings.

(vii) To protect the seed-beds from rain and mid-day sun, there should be a cover over them.

(viii) Wood ash mixed with a little kerosene oil and spread around the seed-bed, keep off many insects; and similarly powdered castor cake, if spread around the seed-beds, prevents ants.

Seedlings :

(i) After germination of the seeds, the covering mats should be taken off every evening if no rain is apprehended at night and the covers put on again at 8 or 9 in the next morning.

(ii) Sun-light and air are needed for proper growth of seedlings or else they will grow up into sickly plants. Gradually increase the period of exposure to sun-light as the seedlings grow older. But protection from scorching sun and rains should always be provided.

(iii) Watering should be very gently done so that the seedlings are not disturbed. It is better to damp the seed-beds thoroughly by water at an interval of 2 or 3 days than gentle watering every day. Evening is the best time for watering. Remember—*do not water too much*. Gentle rains are most beneficial to the growth of the seedlings.

Transplantation of Seedlings :

(i) Healthy seedlings which are about 10—15cm. in height of about 25 to 30 days old are most suitable for transplantation. Before uprooting, moist the seed-bed thoroughly. Seedlings should never be pulled up from the seed-bed but always be lifted with a little soil adhering to the roots.

(ii) Evening is the best time for transplanting vegetable seedlings. However, in a cloudy day transplanting can be done any time.

(iii) Seedlings should be planted in holes sufficiently deep for the roots and a good portion of the stem, in straight lines. Press the soil firmly around the roots of the plant taking care not to bruise the plant in any way and at the same time preventing air pockets near the roots.

(iv) It is advisable to plant the seedlings immediately after removal from the seed-bed. In case of delay, protect the seedlings from getting wilted by keeping them in a wet sack in a shady place or by keeping the seedling submerged in water. Nevertheless, in no case the seedlings should be retained for more than 12 hours.



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- (v) After transplanting, watering should be done to enable the roots to establish themselves in the soil and subsequent watering will depend upon the moisture content of the soil.
- (vi) Protect the seedlings from the scorching mid-sun until they are fully established in the soil.
- (vii) Remove weak, diseased seedlings and replace with strong, healthy seedlings in their place.



CHAPTER III

Some common vegetables : Short notes on their cultivation

I. COLE CROPS

Cauliflower :

Cauliflower is the most important and popular winter vegetable cultivated in the plains of West Bengal. The best crop is obtained in a cool, moist climate, although there are varieties which can withstand high temperature.

Fairly deep, loamy soils rich in organic matter and at the same time well drained are most suitable for cauliflower. The crop prefers slightly acidic soils.

Recommended varieties :

Early : Early Patna, Posa Katki, Early Market, Kunwari—Sown from mid May to mid June.

Main : Giant snowball, main crop Patna, main crop Banaras (Sutton)—sown from mid July to mid August.

Late : Snowball 16, Late Banaras, 96-D (self blanching variety), dania (Kalimpong)—sown from mid September to mid October.

About 600—800g of seed is sufficient for raising seedlings in the nursery for planting one hectare of early and mid season varieties. The seed rate for late types of cauliflowers is about 400—500g hectare. For every 600g seed about 24 beds measuring 2.5m. by 1.0m. will be required for transplanting of one hectare land.

Generally, four to six weeks old seedlings are transplanted on a well prepared field. The planting distance is 45cm. each way for early varieties and 45cm. from plant to plant and 60cm. from row to row for late varieties.

Mix thoroughly 15—20 tonnes of Farm yard manure with the soil during land preparation. About 300kg ammonium sulphate, 400kg superphosphate (single) and 100kg muriate of potash should be applied 5cm. deep on both sides of the rows before transplanting. Application of another 250kg ammonium sulphate is advisable for best results. Cauliflowers often show deficiency symptoms for boron and molybdenum. Boron deficiency causes 'brown rof' or 'red-rof' on the stem and curd finally resulting in development of small curd with rusty brown patches. Spray the plant with 0.3—0.4 borax in case of boron deficiency.

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Sometimes deficiency of molybdenum in soil give rise to strap like leaves known as 'whip tail' disease. Application of ammonium molybdate at a rate of 1.0—1.5kg per hectare will correct molybdenum deficiency.

Irrigate the crop as and when it requires watering. Earthing up should be done 6 weeks after transplanting.

Protect the fully developed head from direct sun light by bending or tying a few leaves over it. This will ensure production of attractively pure white curd.

The early types become available within 56—60 days after transplanting. The heads should be harvested at the right stage of maturity, as any delay results in bolting. The yield varies from 90—200 quintals depending on variety, climate, soil and cultural treatments, from 20,000—25,000 cauliflower heads.

Cabbage :

Cabbage ranks second in order of popularity among the winter vegetables grown in West Bengal. This is essentially a cool season



CABBAGE

crop and cannot tolerate warm season at any stage of growth. Natural soils are best suited for cabbage cultivation. There are several varieties of cabbage recommended for higher yield and best quality :—Pusa Drum-head, Golden Acre, Drum-head, Sutton's pride of India, Suttons Earliest, Kalimpong Eclipse Drum-head savoy, Large Blood Red.

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Large varieties are to be cultivated in heavy soils and the small quick growing varieties do well in lighter soils.

Seeds are generally sown in seed-beds towards the end of the rains, but sowing may continue up to November. As a protective measure the seeds are to be treated with "Cerasan" at the rate of 1 tea spoonful per kg seed. Seeds usually germinated within 5—10 days. The seed rate is about 500g hec. for early varieties and 375g hec. for the late ones. When the seedlings become about 10cm in height, they are transplanted in rows, 60cm. apart, the distance between two plants in a row being also 60cm. small and early varieties are planted at 45 cm. spacings. Early sowing are liable to be affected by heavy rains in late monsoon and therefore, planting should be done on ridges.

About 225 kg ammonium sulphate, 35 kg super phosphate (single), 100 kg muriate of potash per hectare should be applied before transplantation. A second dose of 225 kg ammonium sulphate should be applied as top dressing about five to six weeks after transplantation. Irrigate the field immediately after fertilization. Subsequent irrigations will depend upon the moisture content of the soil. Sudden heavy irrigation after a day spell should always be avoided. Weeding and hoeing should be done after each irrigation. Earthing up at the base is essential to ensure good results.

The crop becomes ready for harvest in about three or four months. The yield ranges from 175—275 quintals per hectare, depending on variety season and fertility of the soil.

Knolkhola or Kholrabi :

Knolkhola also is a cool season crop. Green and purple varieties, which differ little in quality are cultivated for the swollen succulent stems of the vegetable. Improved varieties are Earliest white, snowball green, white vienna, purple vienna.

Seed rate per hectare is about 1 kg.—1.5 kg. Seeds are sown in seed-beds from September to November and seedlings at three leaf stage are transplanted in rows 30cm. apart, the distance between plants being 20 cm. The plants should be watered freely. There is no need for earthing up. Other cultural operations are the same as for cabbage.

It takes about six to eight weeks to be ready for harvest. Over staying of Knolkhola in the field should be avoided as it results in fibrous development and subsequent deterioration on the quality of the vegetable.

Average yield ranges from 500 kg—600 kg hectare.

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Brussels sprouts :

The small "heads" or "sprouts" grow in the leaf axils along and around the main stem progressively from the bottom upwards.

The seeds are generally sown in seed beds from August to December. Seedlings should be transplanted about 60cm. apart in lines and require earthing up as they grow, and also a liberal supply of water. Its general cultivation is similar to that of cabbage.

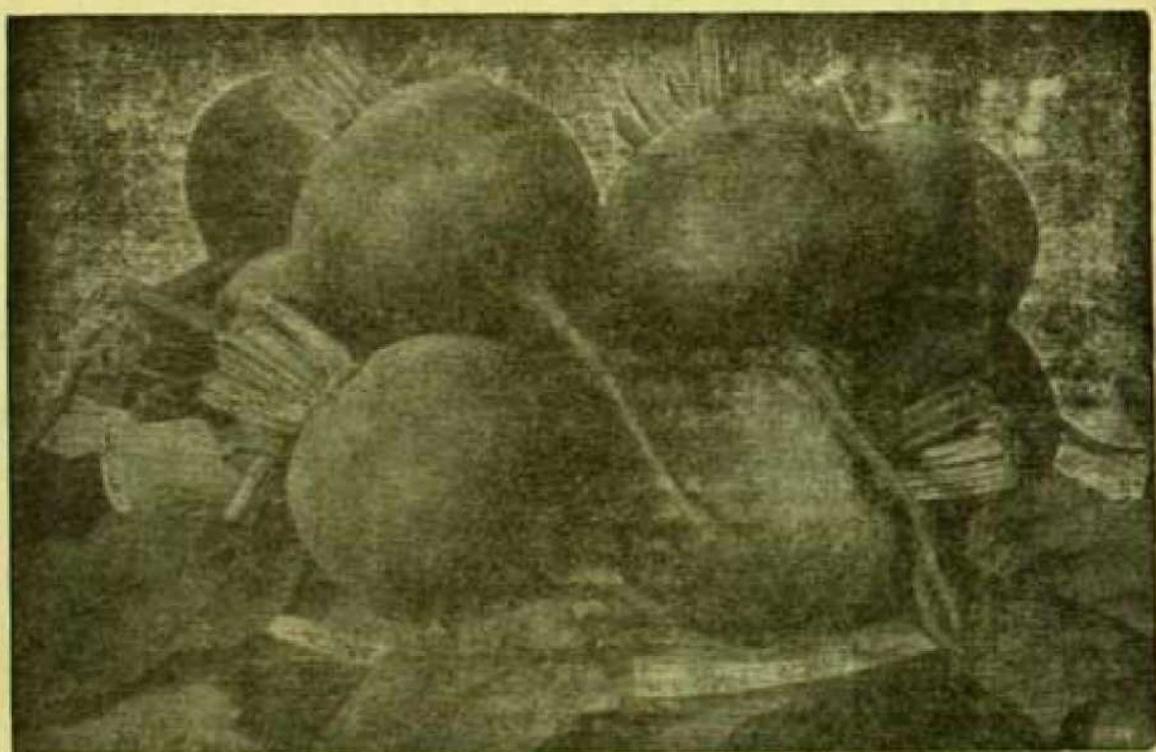
The crop takes about 3 to 3.2 months to be ready for harvest. The lowest sprouts should be gathered first, otherwise these will open out and become yellow.

A well grown plant produces about 50—100 sprouts.

II. ROOT AND STEM CROPS

Beet :

This vegetable is grown for its enlarged roots which are eaten in the form of salad. Although this crop is grown on almost all the types



BEET

of soil, they thrive best on a fairly deep, friable loam, moist but well drained soil with little acidic in nature (pH 6.0). Deformed roots usually develop on badly prepared soils or if the manure is placed too close to it.

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Seed rate : 5—6 kg per hectare

Recommended varieties : Crimson globe, Detroit Dark Red

It is generally sown from August to November. Seedlings may be raised first on seed-beds and then transplanted, or the crop may be raised by direct sowing of seeds in flat beds or ridges at a spacing of 30cm. between rows and 5—10 cm. between plants. It is advisable to pre-soak the seeds overnight, which facilitates quick and uniform germination. The seeds usually germinate in about 6—10 days.

Hand thinning is essential, because there are more than one seed in each fruit and consequently, the plants tend to come up in clumps.

Fertilizers :

About 300—350kg ammonium sulphate, 200—250kg superphosphate (single) and 120—150kg muriate of potash per hectare should be applied for best results.

To get continuous supply of roots, 4 to 5 sowing at an interval of 15 days may be done. Roots should be harvested when they are still tender and soft. Over matured beet becomes bitter in taste and pithy.

Carrot :

This ever increasing popular vegetable is a rich source of carotene, a precursor of vitamin A, and contains appreciable amount of thiamine B₁ and riboflavin B₂.

There are usually three kinds of carrot—the long, the short and the blunt shaped.

Since it is a root crop, the soil should be deeply ploughed and pulverised. Sandy loam soils are most suitable.

Varieties :

Desi—Orange and black, pusa kesar, Indian long red.

European—Nates, Golden heart, Imperator.

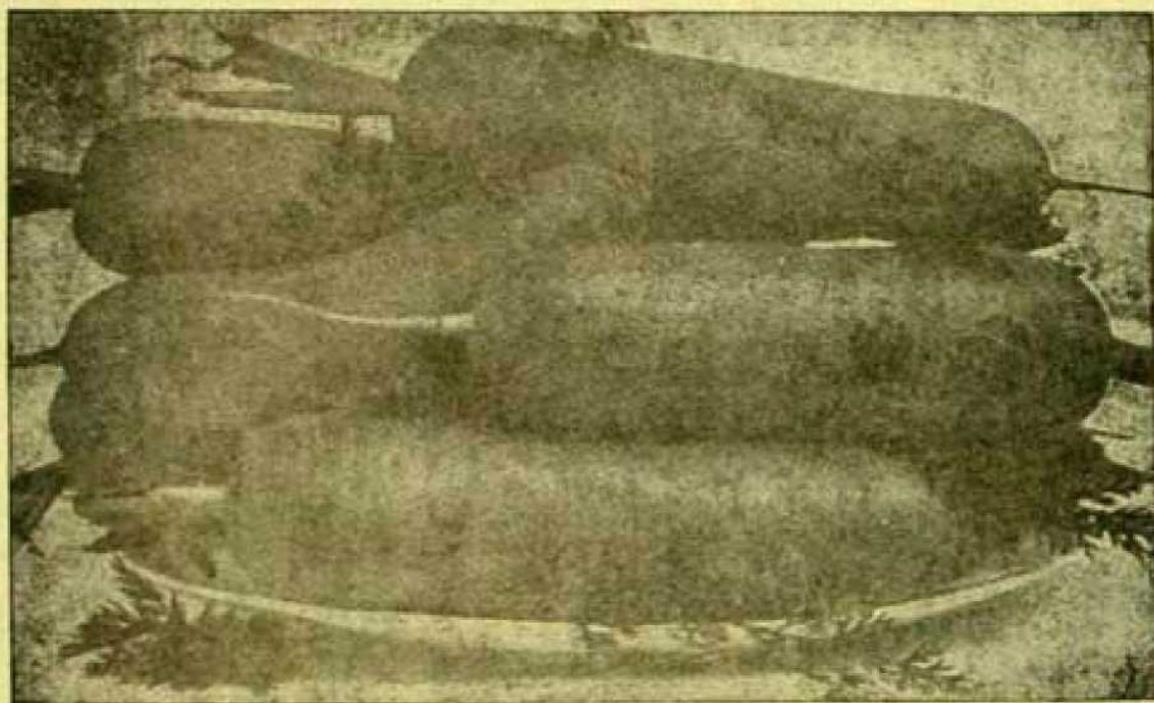
Desi types are sown between the months of August to October and the European types in November. Seeds should be sown on ridges 30cm. apart or on flat beds and seedlings should be thinned out 5—10cm. between plants. To have a continuous supply of good quality roots, successive sowing should be done at an interval of 10—15 days between two sowings at the rate of 7.5—9.0 kg seeds per hectare.

Fertilizers :

160—200 kg ammonium sulphate, 250—300 kg superphosphate and

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150—200 kg muriate of potash is recommended for higher yield of the crop. Too much water is to be avoided, as excessive moisture favours extensive foliage growth and produces poor quality roots.



VARIETIES

The crop becomes ready for harvest is about 2 $\frac{1}{2}$ —3 months. Well grown but tender roots should be pulled up. Roots are likely to split if kept too long in the ground. The yield is about 150—350 quintal/hectare.

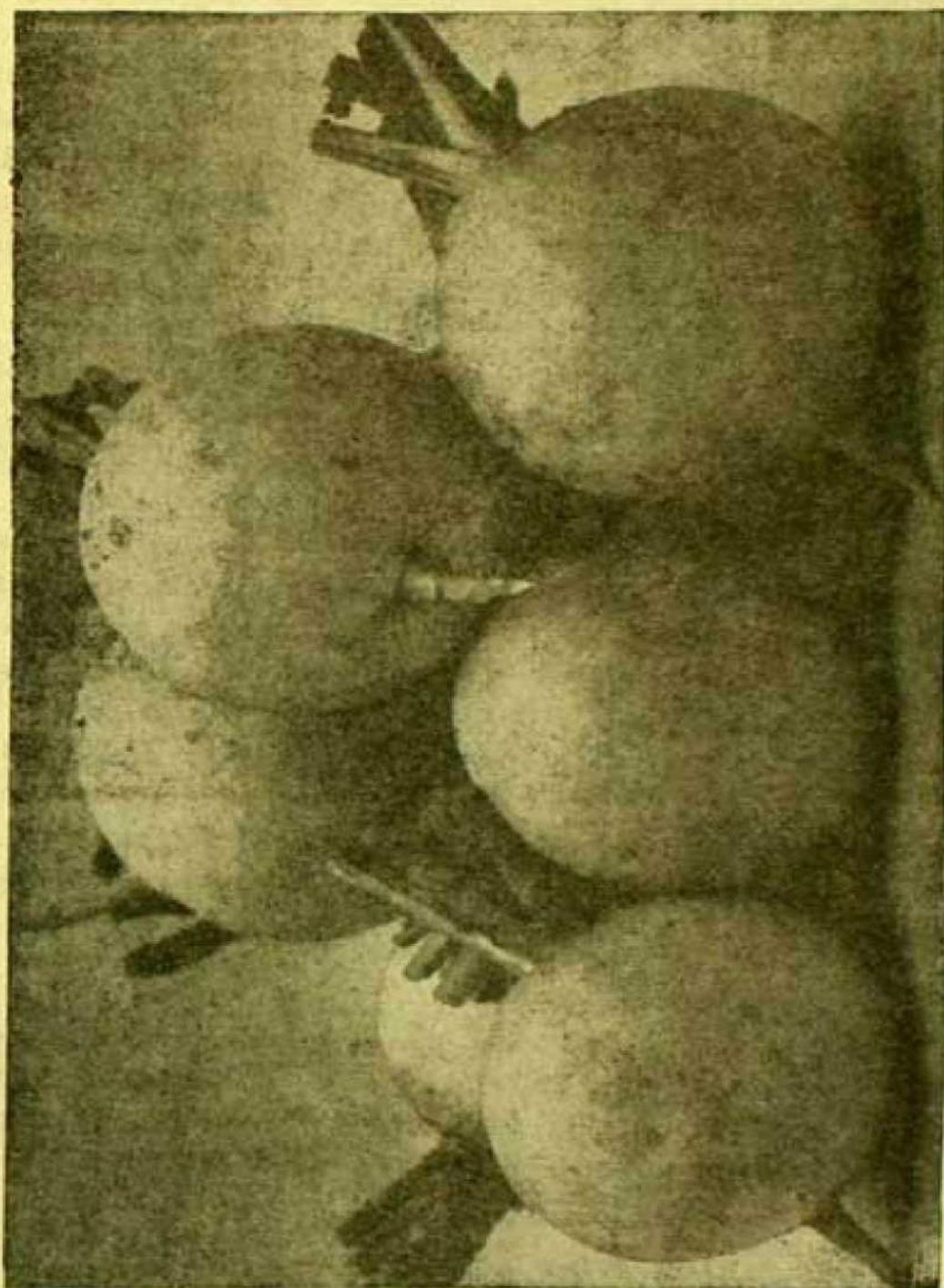
Turnip :

Like beet and carrot, turnip is also a cool season root crop and grows best in a deep, well pulverised, rich loamy soil in an open situation. There are several varieties of turnip suitable for early or late cultivation. The followings are few : Golden Ball, Purple Top, White Globe, Snow Ball, Pusa Kanchan.

About 2.5—3.5 kg seed is sufficient to sow one hectare of land. Seeds may be sown from September to December. 1 cm. deep, in rows 30cm. apart. Seeds usually germinate within 10—14 days. When the plants are about 15—20 days old, thinning should be done by retaining healthy plant at a distance of 10—15 cm. between plants. Crowding of plants should be avoided, as in that case roots do not form properly.

Fertilizers :

Twenty metric tons of farm yard manure should be applied during land preparation. Apply 300kg ammonium sulphate, 80kg superphosphate and 100kg potassium chloride per hectare as top dressing.

**TURNIP**

During dry months, plenty of moisture must be made available to the plants. Turnips grown under moisture stress condition, become exceedingly strong in flavour and if growth is checked by drought, the roots become stringy and tough.



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It takes about 6 to 8 weeks for the crop to be ready for the table. The yield is about 200 quintals/hectare.

Radish :

It is a popular winter vegetable widely grown in the plains of West Bengal. There are varieties suitable for cultivation in summer rains also.

It is also a root vegetable and required a deeply cultivated and well pulverised sandy loam soil, free from all bumps of earth and manure.

According to shape, there are three principal kinds of radish—the long shaped, the oval shaped and the turnip shaped. Recommended varieties : White long, Red long, Jaunpuri giant, Pusa Desi, Pusa Himani, Contai long, Chinese white, Scarlet globe (Sutton), Crimson Breakfast.

Seed rate varies from 6-10 kg/hectare. Seeds are sown at intervals of 8-12 days from July-January, in rows 15cm. apart. After sowing, the ground should be well compressed, as otherwise the roots will not be well formed. Seeds usually germinate within 8 to 10 days. Seedlings should be thinned out 7.5-10 cm apart. An application of fertilizers mixture containing 160-200kg ammonium sulphate, 250-300kg superphosphate and 150-200kg muriate of potash gives higher yields. Radish requires constant weeding. Too much watering and application of fresh manures cause forking of roots. The crop becomes ready for harvest in about 4 to 7 weeks. Harvesting should always be done when the roots are still tender. The roots become pithy and unfit for consumption when they attain full maturity. Yield : Indian varieties—150-175 quintals/hec. European varieties—50-75 quintals/hec.

Potato :

Potato is undoubtedly the most valuable edible and among vegetables the most generally and widely consumed in India. Cool climate is most favourable for potatoes cultivation. It requires well drained sandy loam soil with plenty of organic matter for best growth and production.

Recommended varieties :

Early : up to date, Great Scot, gola Magnum Bonum, Military special.

Medium—Darjeeling Red Round, Kufri Red, Kufri Kundan, Kufri Kuber.

Late—Patna white, Kufri white.

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Planting is generally done from the middle of October to the middle of November in the plains. Tubers are planted in rows, 30-40cm. apart, either whole or cut, according to their size, being laid 7.5cm. below the surface with a spacing of 22.5 cm. between each. When whole tubers are used, the best ones for planting are the medium sized i.e. those which are about 3.5 to 4cm in diameter. The tubers when cut into sets should be such that each set has at least two eyes. For planting, furrows are opened 30-37.5cm. apart, depth being 7.5-10 cm. Manures are spread on the furrows and thoroughly mixed with the soil and then the seed tubers are planted in them, with the buds facing upwards.

The crop requires good cultivation, irrigation and heavy manuring. About 300 to 400 quintal of well rotten farm yard manure (F. Y. M.) should be thoroughly incorporated with the soil a month before planting. Apply 400 kg. ammonium sulphate, 500 kg. single superphosphate and 150 kg. potassium sulphate per hectare in furrows at the time of planting. Another 100 kg. of ammonium sulphate may be given at the time of earthing up.

Four to six irrigations are necessary depending upon the season. The first irrigation is given immediately after planting and subsequent irrigations are given at an interval of 10 to 15 days. After each irrigation, the soil should be well loosened. As the plants grow, they are earthed up to encourage root development. Production of a crop depends on the thoroughness in cultural operations. Adequate hoeing and control of weeds help in the conservation of moisture.

The crop become ready for harvest in 3 to 3½ months, when the stems show withering and the leaves dry up.

Potato tubers should be lifted with a "kodali", care being taken not to damage the tubers, as damaged tubers are liable to become diseased, and infect the sound ones.

A well grown crop will yield on an average 200-300 quintals per hec. For storage it is necessary to cure the fresh potatos by keeping them at room temperature for about a week, which causes thickening of the skin and healing of wounds, if any.

Sweet Potato :

This is a warm season crop and cannot stand frost. Sandy loam soil is best suited to this crop. It prefers a slight to moderately acidic soil. Sweet potatoes are propagated by cuttings of the vine from the previous crop or from the vines raised from tubers in the nursery. Cuttings are planted during September-October in rows, 90cm, apart.

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About 40-45 thousand cuttings are required to plant one hectare. Each cutting should have at least four nodes. Middle portion of the cutting is buried about 10cm. deep leaving both the ends exposed. Cuttings should be taken from the upper portion of the vine, as these produce more tuberous roots. The first irrigation is given immediately after planting and subsequently after every 10 days.

A fertilizer mixture consisting of two parts of bone meal, four parts of ground-nut cake and one part of potassium sulphate should be applied at the time of planting at the rate of 650 kg. per hectare.

During crop growth at least two earthing up should be given to ensure proper root development. The crop gets ready for harvesting in three to four months from planting. When the leaves and vines begin to turn yellow, stop irrigation and dig out the tubers. Ripe tubers cannot be stored well in the ground as such, however, these can be safely stored for a few months in dry sand in an airy room.

Recommended varieties :

1. White-skinned and white-fleshed : Pusa suffaid, Tie Shin Tun, F. B. 4004
2. Red-skinned and white-fleshed : Pusa Lal: F. A. 17 Red
3. Yellow-skinned and yellow or orange-fleshed : Golden Skin Yam, To. 2442, Gold Rush, All Gold, Pusa Sunehri
4. Purple-skinned and Yellow or Orange-fleshed : B. 5941, B. 4306

Yield—100—150 quintals/hectare.

Arum :

This crop grows well on marshy land. It is a warm season crop and can be successfully grown as a summer crop as well as a rainy season crop. It is propagated by means of corms (commonly known as tubers). Planting is done 45-60cm. apart in rows and 20-30cm. apart in lines, from the middle of March to the middle of June. Light irrigation after planting ensures rapid and uniform sprouting of tubers. One or two earthing up will be beneficial. Periodical removal of side-shoots increases the yield. Apply 60-80q FYM, 130-150kg superphosphate, 120kg muriate of potash and 56-75kg ammonium sulphate at the time of final preparation of land. At the time of first and second earthing up of the plants two top-dressing at the rate of 75-90kg with ammonium sulphate are to be applied. So Kalla Kachu, Dhali Kachu and Sar Kachu (aquatic) are the well-known varieties for eastern India.



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Harvesting takes place from the middle of August to the middle of November. Yield varies from 200-250 quintal/hec.

Yams :

Varieties differ greatly in size and colour of roots. Deep, rich, friable, well drained soil is ideal for yam cultivation. This crop is propagated by tuberous roots. Planting is done in pits, 1—1.5m apart, from the middle of April to the middle of June. The vines should be supported on stakes or on trellis. Other cultural operations are the same as for arum.

Harvesting takes place after 8—9 months of planting. The yield is about 100--125 quintals/hec.

Elephant's foot :

Elephant's foot is generally of two kinds—one when eaten, causes irritation to the mouth and throat, and the other one is non-irritating and is superior in quality. The crop grows best in a rich sandy loam soil. It is propagated by small corms, weighing a few grams. It takes three to four seasons for this corm to become a few kilogram in weight. Planting is done in pits, 60—75cm apart, from the middle of May to the middle of June.

It is ready for harvest after six months, when the tops start withering in the month of Oct.—Nov. The yield is about 125—150 quintals/hec.

III. BULB CROPS

Onion :

Onion can be grown under a wide range of climatic conditions, but it grows and yields best in a mild season without great extremes of heat, cold or excessive rainfall. It is not exacting in its soil requirement, however, deep, friable loam soil containing ample organic matter favours production of excellent crops.

Recommended varieties :

Large-sized onions : Bellary of South India, Fanjira and Dhulia of Bombay, Patnai Silver and Patnai Rid.

Small-sized improved local : Prize Taker, Yellow Globe, the Qwen, and Paris Silver-skinned.

45 gram of onion seed will be sufficient to sow a 100 meter row. Seedlings may either be raised in seed-beds and then transplanted when

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6-8 weeks old, or seeds are sown direct in the ground and seedlings are thinned out 10-15cm. apart. Sowing may continue from September to November. Seeds take about 2 to 3 weeks to germinate. Transplanting is done when the seedlings are 15cm. high in lines 20cm. apart. For early crop medium size bulbs are dibbled 15cm. apart on the sides of ridges or in beds.

Picking onions are a small variety, and should be sown closer i.e. about 7.5-10cm apart each way.

Irrigation should be given whenever necessary. Starring of the soil is necessary after each irrigation.

A fertilizer mixture containing 250kg ammonium sulphate, 200kg superphosphate and 200kg muriate of potash per hectare should be applied before planting. A side dressing with 250kg ammonium sulphate may be given one month after sowing or transplanting. Alternatively, 20 tons FYM per acre is applied before sowing or transplantation and 125kg ammonium sulphate is top-dressed twice, once at 25 days and 45 days after sowing or transplantation.

Onion crop is ready for harvest in three to five months after transplanting. Take out the bulbs when about 70% leaves have withered. The average yield is about 125—200 quintals per hectare depending on varieties and method of culture.

For seed production, bulbs should be planted in rows, 45cm. apart, and 30cm. from each other. Only sound well shaped bulbs should be selected. The tops should be cut off with a sharp knife, and the lower two-thirds should be taken for planting ; this gives stronger flower stalk. The average yield of onion seed is about 350—400kg per hectare. Beside the seeds, 2,500—3,000kg of bulbs are obtained. The bulbs produced are of poor quality and are unfit for preservation and therefore, should be disposed of immediately.

Garlic :

Garlic is an important condiment, or spice widely used for flavouring vegetable and meat dishes. Garlic has also wide medical uses. It prefers a cool climate and short days. Garlic requires well drained loamy soil rich in organic matter. In the plains, it is planted in September—October. Bulbils (small bulbs) are used for planting and about 150—200kg bulbils are required to plant one hectare of land. They are dibbled 5—7.5cm. deep, keeping their pointed ends upwards, in rows 15cm. apart, the spacing between plants should be 7.5 cm.

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A fertilizer mixture containing 200 kg ammonium sulphate, 300 kg superphosphate and 200 kg potassium sulphate per hectare should be applied before planting. A side dressing of 200 kg ammonium sulphate may be given one month after sowing. Alternatively, 20 tons of well-rotten FYM hectare is to be thoroughly mixed with soil together with 125 kg ammonium sulphates. A side dressing of 125 kg ammonium sulphate is also to be applied one month after transplanting. There are no recognised garlic varieties but Fawari and Rajalle Gaddi are the two well known varieties of South India give higher yields over local types.

Irrigation and other interculture operations are same as in case of onion. The crop is harvested 4½ to 5 months after planting, when the leaves begin to turn yellowish and show sign of drying up. Yield 40—90 quintals/hectare.

IV. FRUIT VEGETABLE

Brinjal :

Although brinjal can be grown almost throughout the year, it flourishes best during a long, warm growing period. The crop can be successfully grown on a variety of soils, but well drained, rich soil suit the most. The crop is sensitive to soil acidity.

Varieties :

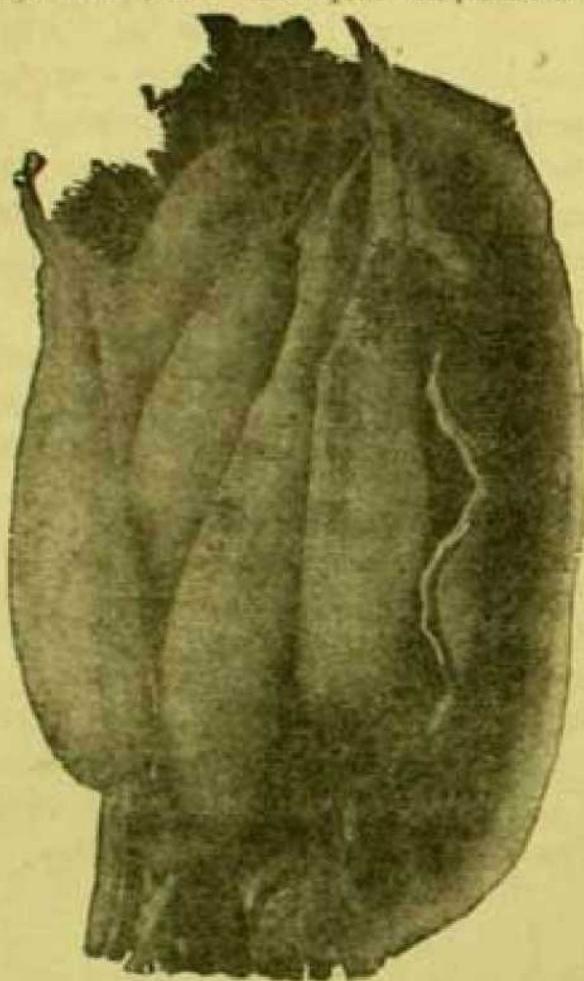
There are numerous varieties, differing in size, shape and colour of the fruit. Some improved varieties are as follows : Pusa Purple Long (PPL), Pusa Purple Round (PPR), Surti Gota, Black Beauty, Banaras Giant, Manjri Gota Muktageshi etc.

About 1/2—3/4 kg of seeds is sufficient to raise seedlings for planting a hectare of land. Seeds are sown in seed-beds four to five weeks before the actual time of transplanting. It is generally grown three times in a year—in the early summer (Feb.-March), during the rains (May-June) and also after the rains (Oct.—Nov.) and for this reason the vegetable is found in the market throughout the year. The seedlings, when become 12—15cm. in height, should be transplanted on ridges, 60—90cm. apart, the distance between plants being 45—60cm.

For best results, thoroughly mix 20 cart loads of farmyard manure (FYM) with the soil during land preparation. Add 250kg ammonium sulphate, 360—480 kg superphosphate and 100 kg potassium chloride before transplanting. Another top dressing with 125—250kg ammonium sulphate may be given one and half month after transplanting.

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Fruiting starts in about 12 weeks. Well developed fruits should be collected before they lose their bright, glossy appearance and become dull. The yield ranges from 90—125 quintals/hectare. To control start



BRINJAL

and fruit borer dust 5—10% BHC or spray Endrex 50 Ec 10 ml dissolved in 1 gallon of water at regular intervals.

Tomato :

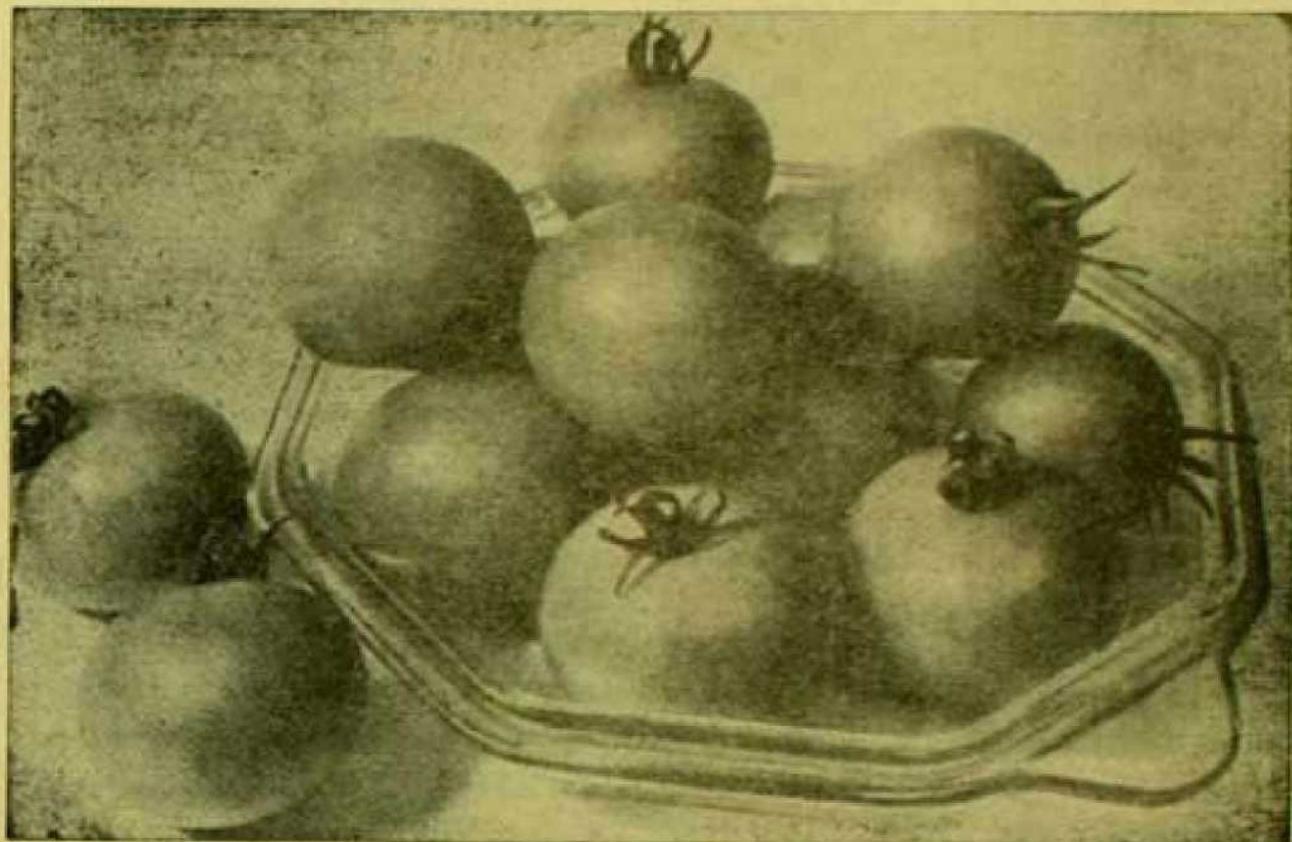
A moderate soil fertility, a uniform supply of soil moisture and a long frost free season of 4 to 6 months favour higher yields of tomato.

There are many good varieties ; of them, best of all are Sioux, Large Red, Marglobe, Oxheart, Pusa Ruby, Red Top, Pusa Early Dwarf, Suttons Early Scarlet are recommended for higher yield and better quality.

Tomato should always be grown in an open situation, as light is essential for the production of sound fruits with attractive colour. About 500—625gm tomato seed is sufficient for planting one hectare of land. Seeds are generally sown in seed beds from July to December. The seedlings 12—15cm. are transplanted in rows, 75—90cm. apart and 45—60cm. between plants. These may also be planted in ridges.

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The tall types must have supports as they grow, specially when they come to fruit. A fertilizer mixture containing 200—250kg ammonium sulphate, 360—480kg superphosphate and 200—250kg muriate of potash should be applied prior to transplanting.



TOMATO

Side shoots and those appearing at the axils of the leaves may be removed to obtain larger fruits. Fruits may be thinned out if the plant is over loaded with them. Irrigation is required, if there is no rain. Avoid sudden irrigation after a prolonged, dry spell. This will cause cracking of fruits. Earthing up should be done before the plants come to flowering.

The crop becomes ready for harvest in about 3—4 months. Changes of colour from green to yellow red, indicates proper stage of maturity for harvest. They should not be allowed to ripen completely on the plant, because, if allowed to do so, they get spoilt by birds or at the time of handling.

The average yield varies from 150—350 quintals/hec depending on season and variety.

Chillies :

Chillies grow best in warm and humid climate, but dry weather is necessary during the ripening of fruits. Well drained loam soils, rich in organic matter are essential for better cropping.



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There are many varieties; smaller varieties are generally more pungent.

Hot chillies:

N.P. 46, Patna Red, G—1, G—2. Sanauri, Sirhind

Sweet pepper :

California wonder, Chinese giant, yolo wonder.

About 1.5kg seed will be sufficient for a plot of one hectare. Seeds are generally sown in seed-beds from the middle of April to the middle of July, and seedlings when 15cm. high are transplanted on to ridges, 60cm. apart and 45cm. between plants. Application of 300kg ammonium sulphate, 350kg superphosphate and 50kg muriate of potash is recommended for one hectare of land. The whole of phosphorus and potash should be applied before transplanting. The ammonium sulphate should be applied in three spit doses—fifty per cent before planting, and the other fifty per cent may be applied equally one and two months after transplanting.

Regular and careful irrigation is an important factor for obtaining best results.

The yield of chillies is about 100 quintals of green fruit per hectare or 10—15 quintals of dry fruits. Harvesting starts from the middle of December and continues up to middle of March.

Lady's finger :

Lady's finger requires a long and warm growing period. It thrives well on all kinds of soil provided they are well manured and well drained.

There are several kinds of tall and dwarf varieties. The dwarf kinds are the earliest. Improved varieties from I.A.R.I, New Delhi are Pusa Mokmali, Pusa Sawani, Lucknow Dwarf, Long green, velvet green, Smooth Velvet-Long White are some of the high yielding varieties.

Seed rate is about 10—12 kg per hectare. The seeds should be soaked for 24 hours before sowing. The seeds are directly sown in the well prepared ground from the middle of April to the middle of June. It may be sown earlier in Feb.—March, if there is irrigation facility. Spacing varies from 60 to 90 cm depending on varieties.

Apply 150kg superphosphate and 50kg muriate of potash before sowing. Top dress with 100 kg of ammonium sulphate one month after sowing and again with another 100kg of ammonium sulphate one month after the application of the first dose. Application of 80kg FYM/hectare before sowing and placing 60 kg ammonium sulphate at the base of plants at fruit bud formation before irrigation may also be practising.

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During the dry months in summer, irrigation is essential for proper weeding and inter-culture should be carried out at regular intervals to obtain best results.

Harvesting commences six to seven weeks after sowing. The pods should be plucked when they are young and soft, as otherwise they become too stringy for table use. Pods allowed to ripen in a few plants may provide sufficient seed for the next year. The yield ranges from 60—100kg green pods per hectare.

V. POD VEGETABLES

Beans :

There are many types of cultivated beans namely, French bean or Kidney bean, broad bean, hyacinth bean or sem, sword bean, cluster bean, soybean, lima bean, velvet bean etc.

French Bean or Kidney Bean :

The varieties of this widely cultivated vegetable are grouped into two categories—(i) bush types, having short erect stem and —(ii) pole type, having longer internodes. Most of the varieties are sensitive to high temperature and frost. Mild climate is most suitable for this crop. Beans grow well on all types of soil ranging from light sand to heavy clay.

Seeds are generally sown in rains (July—Sept.) or in Spring (Feb.—March) seed rate for bush type is about 80—90kg/hec and that for the pole type is about 25—30 kg/hec. The row to row spacing is about 60—75cm. for bush varieties. In case of pole varieties, five to six seeds are sown in hills about 1 meter apart, which, however, when thinned to 3—4 plants/hill proper staking is required for pole varieties.

Application of 250kg ammonium sulphate, 500kg superphosphate (single) and 125 kg potassium sulphate or muriate of potash per hectare is recommended. Always try to avoid excess moisture in the field.

Green pods are usually harvested before they reach full maturity and seeds still remain small and tender. Dry beans are harvested when the pods are fully ripe and the colour changes to yellow. The yield of green pods in bush varieties ranges from 3,000 to 4,000 kg/hec. Yield of dry beans varies from 1,200—1,800 kg/hec.

Cluster beans :

It is essentially a warm season crop and is generally sown twice in a year in spring (Feb.—March) and in the rains (June—July). Well drained sandy loam soil is best suited for it.

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Recommended varieties :

Pusa Mausumi (for rainy season)

Pusa Sadabahar for both rainy season and spring

Pusa Nanbahar



BEANS

The seed rate is about 10—15kg/hec. The seeds are sown in lines 5—6cm. apart, the spacing between plants are kept at 20—30cm. The yield of green pods varies from 60—75 quintals and that of dry seed 6.5—7.5 quintals/hec.

Sem or hyacinth bean :

Sem, a very popular vegetable of West Bengal, can be successfully grown on a wide range of soils, but loamy soils with high organic matter



GROW MORE VEGETABLES & EAT MORE VEGETABLES 31

being best suited for it. The seeds are sown in June—July either by dibbling or by drilling in rows 1 meter apart. Twelve to fifteen kg seeds are required for planting one hectare of land. The plants coming to flowering in Nov.—Dec. continue to do so during the whole winter and spring.

Recommended varieties :

Deshi, Andue, Asparagus Sorell, Altapati, Makhan Kamranga, Baghmaka, Sada, Ghrita, Kanchan.

Apply 100—150q FYM plus 250kg Superphosphate and 50kg muriate of potash before sowing seeds.

The yield ranges from 80—100q of green pods per hectare.

Peas :

This popular and most widely cultivated vegetable is grown in the plains of West Bengal from September to March. There are endless varieties of both tall and dwarf kinds, early, mid season and late. The following are a few recommended for high yield and better quality. Bonneville, early Giant, early Wonder, Sutton's show perfection, Sutton's pioneer.

The seed rate ranges from 45 to 55kg/hec. Seeds are generally sown from August to January, 2.5cm deep, in rows 60cm apart for the dwarf varieties and 90—120cm. apart for the tall ones ; the spacing between plants being 10cm. for the dwarf varieties and 15—20cm. for tall varieties. Six to Seven hours soaking of seeds prior to sowing hastens germination process. The seeds germinate within a week to 10 days and when the plants are about 15cm. in height, put in bamboo or jute sticks to provide them with proper support. The dwarf varieties do not require such staking. Fifty to hundred kg ammonium sulphate, 200—250 kg superphosphate and 100—150 kg muriate of potash per hectare should be applied as top dressing in two split doses—once at the early growth period and again at the flowering stage. Top dressing with fertilizers should always be followed by irrigation. When the plants come to flowering, they should be copiously watered ; this keeps the fruits tender and prevents them from ripening too soon.

Plants come to flowering in about eight weeks after sowing. Flowering, fruiting and harvesting continues for about six weeks. For vegetable purpose, well filled up pods changing colour from dark to light green should be plucked. Yield ranges from 30 to 100 quintals per hectare depending on the variety, time of sowing and fertility of the soil.



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Cowpea :

This warm season crop grows almost in all types of soils, if they are well drained and well supplied with organic matter.

About 12—14kg seeds are required to sow one hectare of land. The seeds are generally sown from the middle of April to the middle of June. A fertilizer dressing continuing 50—60kg ammonium sulphate, 200—250 superphosphate and 100—150kg muriate of potash per hectare is recommended to obtain maximum yield.

Recommended varieties :

Pusa Phalguni, Pusa Barsati.

The crop becomes ready for harvest in two to three months. The yield is about 14—18 quintals per hectare of dry seed and 30—70 quintals green pods per hec.

VI. CUCURBITACEOUS CROPS

Cucurbitaceous crops cover a major vegetable group in West Bengal. Absence of a preparation with cucurbit is supposed to be incomplete in all parts of the state. Cultivation of cucurbits mixed with potato has become a regular practice for the potato growers. With extension of irrigation facilities, West Bengal is accommodating many times more areas than in the past for this crop without disturbing the area under other crops. The cost of cultivation of these crops is appreciably lower than any other vegetable crops except parwal. Some of the cucurbits are eaten raw or as cooked vegetable and others are eaten ripe.

Pumpkin :

The pumpkin is a warm season crop but grows well in every state and in both summer and rainy seasons because of its wide adaptability. About 5kg seed is required for one hec. of land. Seeds are generally sown in February to March for summer crop and in May for rainy season crop. Sowing is done in hills of about 75cm in diameter, 1.5—2.0 m apart. Four to five seeds may be dibbled 2.5 cm deep in each hill, however, the seedlings are thinned to 2 to 3 per hill. It is desirable to add a mixture of about 1kg of compost, 15g of superphosphate and 15g of ammonium sulphate to each hill before sowing. The vines are supported on trellis or trained to spread over the thatch of a house. Irrigation is not required for the rainy season crop. However, for summer crop, adequate irrigation should be given immediately after sowing and subsequently at 6 to 7 days' intervals. Two more split application of

GROW MORE VEGETABLES & EAT MORE VEGETABLES 33

ammonium sulphate at the rate of 15g per pit is to be made at flowering and fruit development stages. On account of high cross-pollinated nature of the crop pure strains are hardly available anywhere. However, different private vegetable seed growers sale varieties according to size, shape, and colour. These are Large Red, Large Cheese, Large Round, American Giant, Yellow Fleshed type, Red Flesh Type, Summer King Kong, Chaitali Kumra (WB), Barsati Kumra (WB) etc.

Fruits become ready for picking after 120—150 days of sowing. The average yield is about 200—250 quintals/hec. When large fruits are desired, keep two to three fruits on each plant. A well ripe pumpkin keeps well and can be safely stored for 4—6 months.

Bottle Gourd :

It is a very popular vegetable, available almost all the year round. There are large number of varieties with different shapes and sizes—the following are most important : Summer prolific long, Summer prolific round.

Green long :

The crop is sown three times in a year : February—March (Summer crop), June—July (Rainy season crop), October—November (Spring crop). Hills for sowing are prepared by digging pits of about 60cm diameter, which are then filled with equal parts of fertile loamy soil and compost. The hills are spaced 1.5—2 m apart. Four to six seeds should be dibbled in each hill and later on 2—3 plants should be allowed to grow in each hill. Seed rate per hec. is 4—5kg.

Training of vines can be done on some support—preferably on bamboo machans and this gives long well shaped fruits.

Fruits are ready for harvesting in 3—4 months after sowing of seeds. Yield is about 150—200 quintals per hec..

Bitter gourd :

The summer season crop (small fruited) is normally sown in February—March and the rainy season crop (Long fruited) is sown in June—July. The seed rate per hectare is 5—6kg. Sowing is done either in hills as in case of bottle gourd or in 2m wide beds, the spacing between plants being 45—60cm. Manuring and other cultural treatments are like those of bottle gourd.

Fruiting starts after about 60 days of sowing and become ready for harvest after 90 days. Average yield per hec. is 1000 quintals.

Ridged or ribbed gourd (Jhinga) and Sponge gourd or smooth gourd (Dundul).

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These two crops like warm humid climate and well drained loamy soil rich in organic matter. Seeds are generally sown from the middle of April to the middle of July in rows 120—150cm. apart ; the spacing between plants is 30cm. For early crop sowing is done from the middle of December to the middle of March. The vines need adequate support and after they are trained on walls, trees etc.

Fruiting takes place after 2 to 3 months. Yield per hec. varies from 100 to 125 quintals.

Parwal or Patal (Pointed gourd) :

This summer vegetable is of great economic importance in West Bengal. It thrives best in well drained sandy loam soil. When grown in river beds, where soil is usually rich in silt, the crop need not be fertilized.

Patal is propagated by vine cuttings taken from the middle of October to the middle of December. Two methods of planting are followed. In the first method, after land preparation trenches of 30cm. deep at 15—20cm. wide are made 1 meter apart. Vine cuttings of about 60cm. long are planted in trenches by end to end methods. In the second method, cuttings are first coiled up in rings and then planted in hills, 1 meter apart each way, alternatively, instead of planting the cuttings straight in the field during October ; these may be stored in sand in the nursery for development of roots and the rooted cuttings are then planted in the field during Feb.—March. No well-recognised varieties have been reported so far.

The male and female vines are distinct and 2 to 5 per cent of male population is sufficient for proper fertilization.

Patal required frequent hoeing for keeping the plantation free from weeds. Occasional watering during summer months help better growth and fruiting. Harvesting of fruits may take place in about 3 to 4 months time. The yield is about 100—150 quintals per hec.

Cucumber :

This crop can be grown twice in a year. First sowing is done in January—February and the second in June—July. Seeds are sown either in raised beds or in hills, 1.5—2.0 m. apart ; plant to plant distance being kept at 90—120 cm. About 2.5—3.0kg seed is required for sowing one hec. Manuring and other cultural requirements of cucumber are like those of sponge gourd or bitter gourd. The crop will



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be available after 90—100 days. The average yield per hectare is 50—80 quintals.

Recommended varieties : Balam Khira, Japanese Long Green, Poona Khira, Darjeeling type, Straight Eight.

Snake gourd (Chichinga) :

Seed rate of snake gourd ranges from 4 to 5kg per hectare. Seeds are generally sown from the middle of April to the middle of July 15cm apart in rows which are spaced 1.5—2m apart. The vines are usually staked up. The soil and climatic requirements and the method of cultivation of snake gourd are the same as for other cucumbers.

Fruiting takes place during August—September. Average yield varies from 100 to 150 quintals per hectare.

Red gourd or red pumkin (Kumra) :

There are many varieties only differing from one another in size, shape and colour of the fruits.

The seed rate is the same as for bottle gourd. Seeds are generally sown in March—April and May, and again from the middle of September to the middle of November. Sowing of seeds is just like that of bottle gourd. It should be grown over a trellis or an out house during the rainy season to prevent the fruit rotting.

Fruits are ready for harvesting in 3 and 4 months after the seeds are sown. The yield is about 100—150 quintals/hectare.

White gourd (Kumra) :

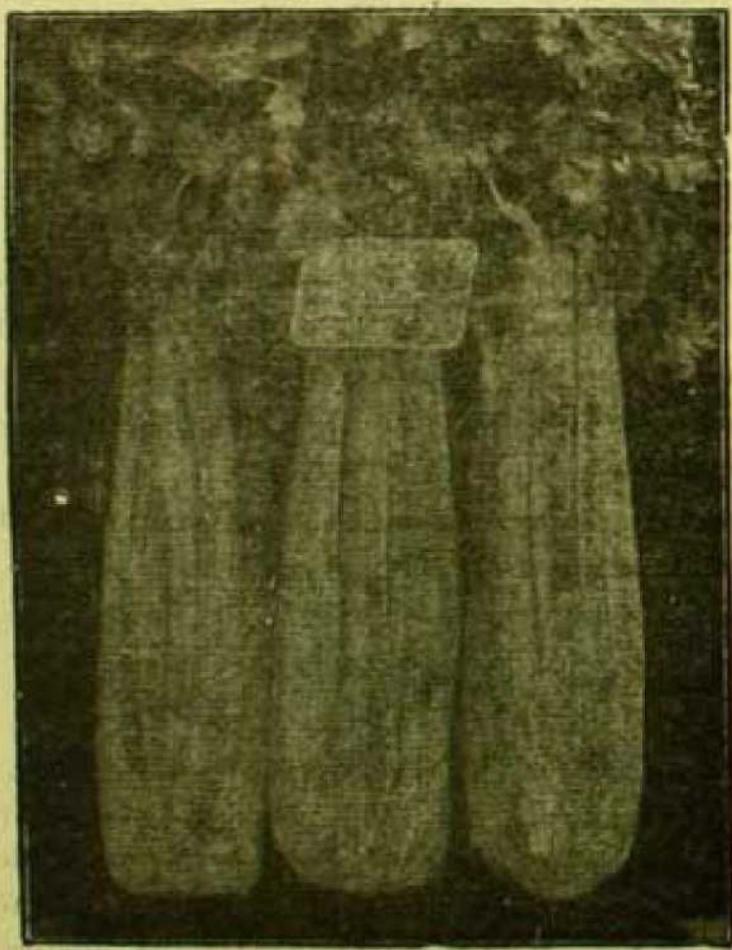
The crop does well in lighter type of soils. Very thorough tillage of the soil is not required. In West Bengal and adjoining states the round and cylindrical types are being cultivated for table purpose. The crop is sown between first week of February to end of March and are harvested from June to July. The system of sowing manuring etc. are the same as pumkin. In early varieties an irrigation is to be given immediately after sowing seeds in pits and then at an interval of 10 to 15 days till the fields remain green. About 150—250q of green or 200—300q ripe white gourd is obtained from one hectare of land.

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VII GREEN VEGETABLE

Celery:

This important salad crop generally is of two kinds—green and yellow, with several varieties under each. Seeds are sown in seed-bed from July to September. Early sowing is desirable, because the plant takes a long time to complete its growth. The seed also takes a long time to germinate—often 30 to 45 days. About 125g seed is required to plant one hectare of land. When the seedlings are large enough (about two months old), they are transplanted in trenches very highly manured with a large quantity of farm yard manure and this should be mixed with sand, to a depth of 30cm. or more. On this a few centimetres of good loamy soil is placed and firmly pressed down. The seedlings are planted on this, 30cm apart. They should be kept moist by frequent watering.



CELERY

The foliage of celery should be tied into a loose heart, and the soil carefully hoed up around the stalk as the plant grows old. Straw envelopes may be tied around each plant to bunch the foliage. Great care should



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be taken during watering so that no water collects in the heart of the plant or else rotting will start.

The harvesting period extends from January to March.

Of all the vegetables, it is with celery that the amateur appears to have little success, because of the erratic germination of the seeds. The essential condition for successful germination is cool weather, the most favourable time for sowing (under cover) being the beginning of a long cool weather.

Parsly :

Its leaves are used for flavouring, for garnishing and to some extent for salads.

Parsly thrives in any soil in a shady situation. Its seeds are very small and germinate slowly, seeds are sown in seed-beds from August to November, and when the seedlings are 7.5 to 10cm. in height, they are transplanted in rows about 15 to 20cm. apart and kept well-watered. Seed may be broadcast and seedlings thinned out.

The crop becomes ready for harvest in 1 to 3 months.

Cress :

The leaves of this cool weather crop are used in salads and garnishing. Seeds are sown from September to February and the leaves become ready for harvest in about 6-8 months after sowing.

Cress requires light but rich soil and adequate watering. If properly managed it can be grown all the year round.

Leek :

Leek is eaten raw alone or in mixed salads or cooked for flavouring soups and stews.

Seeds are sown in seed-beds from September to November, and when the seedlings are about 10-15 cm. high, they are transplanted in shallow trenches, 35-40 cm. apart, distance between plants being 15-20 cm. Seeds may be sown direct in the soil, 1cm. deep and seedlings thinned out to 15-20 cm. apart. The plants should be arched up gradually 2-5 cm every 7-10 days when the plants are two months old. The general culture of leek is very similar to that of onion, but it requires a little more fertilizers than onion.

The crop matures in about 3-6 months after sowing.

Lettuce :

This is a cool season vegetable and is grown for its green tender leaves which are taken in the form of salad. There are two kinds of

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lettuce namely (i) cabbage—head lettuce and the 'cos' lettuce. Each kind has a number of varieties. The 'cos' type is long and upright.

About 80gm seed is required to plant a 100 meter row. Seeds are generally sown in the nursery from September to December and seedlings, when one month old are transplanted in flat beds in rows, about 30cm. apart ; the distance from plant to plant should be 30cm. The crop can also be raised by direct seed sowing in the field, but in that case the seedlings should be thinned out properly at the right time. Leaves become available in about 60 days after sowing. While cutting the leaves proper care should be taken so that the growing point is not injured. Three to four cuttings can be obtained from the same plant. The harvesting period extends till March. Shallow hoeing helps in better growth of plants. Irrigate before the soil becomes completely dry and the plants show symptoms of withering.

Spinach :

Spinach, a very wholesome leafy vegetable, grows well during winter months. It is extremely susceptible to water logging and poor drainage. The seed rate varies from 25-30 kg per hectare. Seeds should be sown in lines from September to December and thinned to about 15 cm. apart ; the spacing between rows should be 25-30 cm. Seeds usually take 2 to 3 weeks to germinate. However, overnight pre-sowing soaking of seeds in water hastens germination. The plants take about 4-5 weeks from sowing to get ready for the first cutting. About 4 to 6 cuttings can be taken safely at an interval of 15-20 days, until the plants come to flowering.

Amaranthus :

Amaranthus is a common leafy vegetable exclusively grown during summer-rains in the plains of West Bengal. There are several kinds of Amaranthus varying considerably in height, size and colour of leaves, branching habit, flowering time and response to cutting.

Amaranthus grows best on well drained loamy soil. The soil should be well prepared and a basal dose of twenty-five tons of farm yard manure and three top-dressings each of 100kg of ammonium sulphate per hectre should be given to the crop. On account of the smallness the seeds should be sown rather shallow, about 0.5 cm deep. Sprinkle water lightly after sowing for satisfactory germination. The seed is sown broadcast or in rows in flat beds after mixing with fine earth for even distribution. Sowing can start from the middle of March and can be continued up to the middle of June. Weeds are a great problem and should be removed periodically. In the spring-sown



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irrigation every fourth or fifth day is desirable for good growth. Harvesting starts three to four weeks after sowing and subsequent cutting can be taken after every seven to ten days ; six to eight cuttings can be easily taken.

Basella (Poi or Puin) :

Puin is grown in the plains as a warm season crop. Being trailing in habit, it is usually grown on trellies. Seeds are sown in pits in May-June. Soil preparation, manuring and other intercultural operations are the same as for Amaranthus.

The crop becomes ready for the first cutting in about five to six weeks and the subsequent cuttings can be taken at an interval of 10-15 days depending on the growth of the plant.

Other common pot herbs :

- (a) Pigweed (Bathua) : Grown in July—August
- (b) Champa Nate : Sown in March—April
- (c) Dengo Sag : Sown in April
- (d) Mint (Podina) : Cuttings are planted in June—July and seed are sown in October.
- (e) Sorrel (Chuka Palang) : Sown in September—October
- (f) Water cress (Halim) : Grows in clear cold, shallow water.

VIII. SOME MINOR VEGETABLES

Parsnip :

Commercially it is not that important as other root crops. Seeds are dibbled in rows, 45cm apart in October—November and seedlings thinned out to 20cm apart. The crop requires a light and rich soil, deeply dug, so that the root is able to penetrate it easily. The soil should be frequently watered. Its cultivation is similar to that of turnip.

The crop attains maturity in 5 months, but those roots which are about two-third grown are the best for table use.

Globe artichoke :

Artichoke or globe artichoke is herbaceous perennial plant grown for its edible flower bud. The above ground portion of this plant dies every year during winter and again emerges in spring.

It is usually propagated by suckers, but can also be propagated by pieces of crowns with a portion of stem.

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Artichoke requires a very rich soil and also abundant watering. Surface soil should be hoed frequently to keep the soil free from weeds.

Plants can also be raised by sowing seeds in seed beds from July to November, and when the seedlings are about 10-15cm high, they are transporated 90-120cm apart each way into trenches, and are deeply dug and well manured.

It becomes ready for harvest in 5-6 months. Harvesting should be completed before the buds become loose and fibrous.

Jerusalem artichoke :

The edible portion of this herbaceous perennial plants in its fleshy oblong tubers, but it is not at all popular in this country, is grown only in home gardens by amateurs.

Jerusalem artichoke prefers a light deep soil. The soil should be well dug, well manured and well pulverised.

It is propagated by tubers which are generally planted in March-April in row 2.5 to 4cm. apart, the distance between plants should be 60-90 cm. The whole tuber or pieces are planted to a depth of about 10cm. The plants grow to a height of about 90-120cm. The soil between rows should be kept well hoed and free from weeds.

Flowers should not be allowed to appear as they reduce the size of the tubers.

The crop is ready for harvest when the tops begin to die back in November-December. The tubers readily wither dry weather and it is better to leave them in the ground until required for use.

Roselle (Patwa) :

Seeds may be sown in seed-beds from March to May, and seedlings transplanted 120cm. apart. This is a perennial crop.

Fruiting starts after about 5 to 6 months.

Yambeam (Sankalu) :

It may be planted from March to June at a distance of 90cm apart. It is a growing creeper grown on ridges and vines are allowed to ramble. It is ready in 4 to 6 months and the edible tuberous roots are taken up in the winter season.

Kankri :

Seeds are sown in pits on well prepared beds, 1 to 1.5 cm, apart, from the middle of March to the middle of May, and the crop is harvested during the rains.



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Kankrole :

It is generally grown from tubers from the middle of April to the middle of June. It requires support for proper growth. Harvesting is done in the rains and in the winter.

Arum (Mankachu) :

It is propagated by corms. Planting is done during the rains, 60 to 90cm. apart either ways. It is ready for harvest from the middle of August to the middle of November. Average yield ranges from 152 to 150 quintals/hec.



APPENDIX I

Manures & Fertilizers

Plants, like animals, require food for their sustenance and growth. If their food supply is insufficient or unsuitable, they cannot properly grow and develop. The chemical elements composing the natural food of ordinary crops are sixteen in number, viz. carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, sulphur, calcium, magnesium, iron, manganese, boron, zinc, cobalt, copper and molybdenum. The first three are obtained from the air and water, while the rests come from the soil. The absence or even deficiency of any one of these elements is disastrous to plant growth and the deficiency of one element cannot be made up by an excess of another. Often the nutrients are present in the soil in reduced amount, or in a state unavailable to the plant. In such cases the plant exhibits hunger signs specific to that element. The deficiency must be made up before remunerative healthy crops can be grown, and it is with this object that manures and fertilizers are added to the soil.

Plant nutrients are added to the soil from two principal sources—organic manures and chemical fertilizers.

Organic Manures:

Organic manures not only supply plant foods, but also add organic matter, which is also needed by the soil to improve upon the physical condition. Plant foods present in the organic matter are slowly available to the plant over a wide range of period. The following are principal organic manures :—

- (a) Farmyard manure, (b) Compost, (c) Green manure, (d) Oil cakes, (e) Sewage and sludge.

Farmyard Manure :

It is the decomposed mixture of the excreta of domestic animals with straw or other litter that is used in the yards or stalls to absorb the liquid portions and to keep the animals clean. It is a slow acting manure, and effects are spread over a number of years. It is obvious that the composition of the farmyard manure cannot be constant, varying with the nature of the animal making the dung, the kind and amount of food it receives, the proportion between excreta and litter, and the nature of the decomposition of the manure. The amount of



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nitrogen present in the animals' food is an important consideration in determining the value of this manure. Generally speaking, animals fed on concentrated feeds, such as oil-cakes yield the richest manure, while those fed on straw and root crops yield the poorest.

Very little care is generally taken by the people to conserve the cattle dung properly, while the urine and other refuses are altogether neglected. The common practice is to stack the dung in the open, exposed to sun and rains, whereby the best part of the manure is altogether lost. The best method to conserve the dung is as follows :

Dig a pit and raise a small inexpensive shed over it, just to protect the manure from the sun and the rains. Plaster the sides and the bottom of the pit with mud and cowdung to make it as impervious as possible. Collect from wastes, waste fodders or weeds and spread this material on the floor of the cattle-shed. It will form a good bedding for the animals and at the same time will absorb all the urine. Most farmers collect cattle dung from their cattle-sheds but they allow the urine to go waste. Urine is rich in plant foods and as such, should it not be wasted. Mix the urine-soaked litter with cattle dung and put it in the pit sprinkle earth over it. Put the second day's collection over the first days collection. Repeat till the heap rises 30cm above the ground level. Cover it with a 5cm layer of soil. You will get well-rotted farmyard manure in about 4 to 6 months.

A wellrotted farmyard manure must have the following characteristics :

- (a) Dark-brown in colour
- (b) Even in textures, with no lumps of fresh straw or any kind of litter
- (c) Fairly moist—neither too dry, nor too wet
- (d) Should contain not less than 1.0% Nitrogen (N), 0.6% phosphorus (P_2O_5) and 0.7% potassium (K_2O).

Compost :

Compost is a very good substitute for farmyard manure. Any kind of plant refuse like weeds from fields, sugarcane trash, cattle-food residues, farmyard sweeping, vegetable wastes even leaves of trees, town sweepings, aquatic weeds like water hyacinth etc. can be converted into a very valuable organic manure suitable for all soils and crops. In West Bengal water hyacinth is a veritable weed doing great harm to the economic life of the State. It is readily available in any quantity almost everywhere in the State, and can be converted into compost, thereby not only producing a very useful manure, at the same time freeing the province of this obnoxious weed.



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There are different methods of composting in vogue in different tracts of India. The method most suited under West Bengal condition is described below :

A level high-land, not liable to flood or water-logging during the rains, is the most suitable site for preparation of compost. It should preferably be in the shade of spreading tree which excludes the sun, thereby preventing drying up of the material. Cattle shed washings and water are essential for the preparation of the compost, and if the site is selected near a cattle shed or a water reservoir, the labours entailed in carrying them will be very greatly minimised.

Whatever plant refuse be available should be collected and brought to the site of the preparation, and spread uniformly and loosely into a layer of 30cm high and 2m wide ; the length depends upon the quantity of the stuff that is available. If dry or refractory materials like rejected paddy straw, sugarcane trash, etc. be used, it is always better to employ them as litter for 2 to 3 days before directly carrying them to the heap. The absorption of cattle urine thereby will hasten their decomposition and also enrich them. Any material which can be used as bedding for cattle should be so used before being put on the layer. Very hard woody materials should be broken up before they are used. The layer should not be trampled or pressed. If bone meal be easily available, it should be scattered on the layer at the rate of 1.5 kg to 2.5 kg per 10 sq.m. If bone meal is not easily available, the final product would be improved by adding a layer of fresh cowdung and then one of earth, each layer about 2.5cm thick. The heap should then be thoroughly moistened, but never wetted, with uniform splashings of cattle shed washings. In the absence of cattle shed washings, urine or fresh dung of cattle dissolved in water at the rate of 1 : 10 or 15 will do as well. After moistening the first layer, a second layer of 30 cm is to be built similarly. This process continues till a heap, 120cm high, i.e. four 30cm layer one above the other is made, and the heap is then to be left undisturbed for the time being. If water hyacinth be used for preparation of compost, there being plenty of moisture in it, no watering, as a rule, is necessary, but same activator will be of great use in promoting fermentation and hastening decomposition of the raw materials. Instead of using water hyacinth exclusively, it is always better to mix up with same (say one third) dry or semi-dry materials in making the heap, and then to moisten the heap with cattle shed washings, or solution of urine or dung in water as mentioned above.

There are two essential factors necessary for decomposition which must always be borne in mind, viz. (1) abundant aeration and (ii) sufficient



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moisture. For aeration, the material should on no account be pressed or trampled down, while being made into heap ; the heap should never be made wider than 2 meter nor higher than 1 meter and at no period should the mass be allowed to turn sodden, neither be allowed to dry out completely. In rainy weather when everything is damp, no watering is at all needed, but during rest of the year the heap should be moistened by watering whenever it shows signs of drying up. No general rule can ever be laid down as to the amount of water or frequency of watering needed for perfect decomposition of the mass. They depend on the kind of plant materials used, the local circumstances, the weather conditions and the season of the year. As a general rule, however, it can be said that watering is required during the monsoon, and also when fresh green stuff like water-hyacinth, market or garden refuse and aquatic weeds are used as the raw material. The maximum watering is required during the hot weather, and when dry materials are used for conversion.

To ensure uniform and thorough decomposition it is necessary to turn over the heap at least twice. The first turning over is to be done when the mass is half decomposed. It takes about a month and a half to reach the stage when materials employed are dry, but less time in case of green stuff. Sugarcane trash takes double the time or even more. The process of turning over is best done by breaking the heap, and making a new one just beside it, in the same manner as above, building new heap from the bottom with the top layer of the old heap, and placing the undecomposed or partly decomposed materials in the interior of the new heap. While breaking the old heap and making a new one, the stuff of similar nature should be put together, leaving aside any hard substance like twigs reeds, etc. to ensure uniform final product. If the mass lacks sufficient moisture, as it usually does, when being turned over, watering should be done to bring about the degree of moisture required for completion of the process of decomposition. The new heap should constantly be kept moist.

The second turning over will be required about a month after the first, and the new heap moistured similarly until the mass is completely converted into humus and fit for application to the land. At the time of the second restacking the top of the heap should be made of the shape of the top of a thatched hut with a view to presenting rain water from getting in. This is all the more necessary when the final product is not likely to be required for immediate use.

Under proper moisture conditions, it ordinarily takes about 3 months and a half for conversion of the refuses into compost. A longer time is taken in the dry season, or when the stuff containing refractory

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elements is used as the raw material, and less time is required during the monsoon or when green material is used.

Green Manuring :

Green manuring is the practice of enriching soil by ploughing in of plant material, mostly of leguminous plant. Leguminous plants, through the bacteria living in the nodules on their roots, have the special power in fixing the free nitrogen of the atmosphere to the soil. On ploughing in such crops, their roots, stems and leaves contribute a valuable supply of nitrogen to the soil, along with organic matter. Of these crops, dhaincha (*Sesbania acuteata*) and sunhemp (*crotalaria juncea*) have been proved to be most suitable. As regards the time of ploughing under the green manure crops, much depend on the crop which is intended to benefit. It is recommended that all green manuring crops should be ploughed in, if possible, when they are in flower, for it is this period that they contain the largest quantity of nitrogen. It is of utmost importance to have the plants thoroughly incorporated with the soil.

Advantages of green manuring :

- (1) The physical condition of the soil is improved
- (2) It supplies nutrient elements to the plant. Decomposing organic matter has a solubilizing effect on phosphorus, potassium and trace elements
- (3) Green manures are particularly valuable in saline soils, because in comparison with fallow they reduce evaporation from the surface soil and hence the salt content therein
- (4) weeds are suppressed by green manure crops

Oilcakes :

Oilcakes are valuable organic manures containing appreciably high amount of nitrogen, besides small quantities of phosphorus and potassium as well. The chief oilcakes are—mustard cake, castor cake, linseed cake, cotton seed cake, cocoanut cake. Oilcakes are quick acting manures and they show their effects in a week or two after application. As edible oilcakes are valued more as cattle feed, they are uneconomical for use as manures. Before applying an oilcake to the soil, it should be broken into meal and then broadcasted over the land evenly, or in places where the plants are expected to grow.

Sewage and sludge :

Sewage is the refuse conveyed away by sewers in places which have adopted the water-carriages system, and is a mixture of human



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excrements discharged from water closets and privies, water from kitchens containing, vegetable, animal and other refuse, soapy water from domestic and other sources, drainage from stables of horses, cattle, and other animals. Broadly speaking, sewage is a mixture of solids and liquids.

The manurial properties of sewage have been utilised from times immemorial in many countries. In some cases sewage in its crude form is applied, and in others it is purified before use. Continuous irrigation with raw sewage is not desirable, because it spoils the soil and increases the hazards to health. The Colloidal solids in the suspension choke the soil pores and as such the crops begin to suffer for want of aeration. It also disturbs the distribution of the microbial population in the soil. Sewage irrigation should be restricted to sandy soils having good under-drainage. Moreover, the land should be rested periodically to permit soil recovery.

Sewage irrigation should preferably not be followed in vegetables which are consumed uncooked.

The solid matter in the sewage which is known as sludge, is of considerable manurial value; it contains nitrogen, potash and also a large amount of organic matter, which tends to lighten the soil and render it porous. But experts hold the view that if the sludge is applied to the land in large quantities and regularly, it clogs up the soil. It should, therefore, be used in small quantities and intermittently before use it should be powdered up and mixed with the same volume of soil, and the mixture then used. When the sludge is watered it gives a slightly unpleasant smell for a few days which gradually passes off.

Fertilizers :

Fertilizers or artificial chemical manures contain plant food in such form that is directly available, either at once or after a short time, for the needs of the growing plants. One or more of the elements—nitrogen, phosphorus and potassium constitute the essential part of a fertilizer. These are called direct fertilizers as opposed to indirect fertilizers, which serve to render the food already present in the soil, the most common and common line. Fertilizers are divided into :

Nitrogenous fertilizers :

Nitrogen is mainly concerned with the vegetative growth of the plant. A deficiency in nitrogen in the soil results in a stunted growth of the crop growing on it. Some soils fail to produce good crops in specially vegetables which become sickly and yellow in colour soon after they appear above the ground. This condition



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indicates a lack of nitrogen available for plant use. The presence of nitrogen in the soil darkens colour of the foliage of the crop, thus showing healthy state of growth. Nitrogen helps in seed formation and increases the food and feed value of crops. An excess of it is not favourable to the production of flowers. Moreover, such crops being more succulent in character became susceptible to pests and diseases.

Generally speaking, nitrogenous fertilizers (i) tend to increase the vegetative growth of the plants and (ii) give a good start to them. Those crops which are valued for the leaves only, such as cabbages, pot herbs are specially benefited by these fertilizers. Ammonium sulphate, ammonium nitrate, urea are some of the most common nitrogenous fertilizers.

Phosphatic fertilizers:

Phosphatic fertilizers have the opposite effect to nitrogenous fertilizers, checking rampant growth and encouraging the early formation of flowers, fruits and seeds. In case of phosphorus deficiency, the plants have small root system and their growth is stunted. Optimum quantity of phosphorus available to the plant in combination with nitrogen balances their shoot and root growth. In general, phosphatic fertilizers (i) tend to stimulate the early development of the young seedlings to a remarkable extent, (ii) lead to the tillering of the cereals, (iii) tend to increase the flowering and fruiting tendencies of the plant, (iv) tend to make the fruits and roots of the crop sweeter and (v) make ripening of crops to take place earlier.

Bonemeal, superphosphate, rock phosphate, basic stage are some of the most important phosphatic fertilizers.

Potassic fertilizers:

Potassic fertilizers are of benefit to plants in all stages of growth, and enable them to withstand adverse conditions of soil and climate. Crops growth on soils well supplied with potash are more resistant to diseases and pests. Potassium is intimately connected with the formation of carbohydrate and its movement from one part of the plant to another. It is helpful in the production of leaves, elaboration of acid juices of fruits formation of roots and also to flowering and fruiting. Potassium chloride (muriate of potash) and potassium sulphate are the two most commonly used potassic fertilizers.

Lime:

A word or two must be said about lime, which is a natural constituent of all soils. In many instances, there is sufficient lime for the needs of



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most plants, but where lime is deficient in quantity it must be added before healthy crops can be raised. While actually not a manure, it increases availability of plant foods especially phosphorus and potassium. It flocculates clay soils, prevents cracking and on sandy soils cements the particles together. It counteracts acidity, and forms a base on which other acids may combine. Liming favours symbiotic and non-symbiotic nitrogen fixations. Gardens should be thoroughly limed every 3 or 4 years. A light dusting of crushed limestone or slaked lime spread over the bed and dug at least one month before the application of manures will be beneficial to the crops. Lime plays also an active part in reducing attacks of many diseases and insects.

General Instructions :

Complete fertilizers are those which contain all the three principal plant nutrient elements, namely, nitrogen, phosphorus and potassium. Farm-yard manure or compost is the best known natural complete manure and when either of them can be obtained, its use is highly recommended not only because of the plant food it contains, but also because of its physical effect on the texture and water holding powers of the soil. The best results are, however, obtained by a judicious combination of farmyard manure or compost with chemical fertilizers. It must, however, be remembered that farm-yard manure or compost should be dug well in advance before sowing or planting, but chemical fertilizers are generally applied at the time of sowing or planting or a few days before. Depending on the requirement of the crop, further application can be made during the period of growth.

Various kind of crops exhibit great differences in their requirement for a particular nutrient elements. Some crops have a greater demand for an element, others may have greater demand for another. Root crops such as carrots, turnips, best require large quantities of nutrients for proper growth and development. Potatoes respond to and require a fertilizer containing a high percentage of potash. Other crops respond better to fertilizer containing a high proportion of nitrogen and phosphorus. Leguminous crops need especially phosphatic and potassic fertilizers, but do not require much nitrogen, for the reason that they can obtain nitrogen from the air. Different crops, therefore, require different amount of nitrogenous, phosphatic and potassic fertilizers and it is thus advisable due consideration to this fact should always be given very carefully, and a knowledge as to when, how, and in what quantities it should be applied is essential. The manurial requirements of the individual vegetable crops are given under the method of cultivation of each of them.



APPENDIX II

Life history of injurious insects and common remedies to combat them

The life history of an insect is divided into four stages—the egg, larva, pupa and adult. The larval and pupal stages vary considerably. The former is the period of growth and the latter is the period of change or metamorphosis, when the larva is transformed into adult. It is a very curious process. During the pupal stage the greater part of the organisation of the larva is destroyed and remodelled into the adult, the fully developed insect, which eventually comes out of the pupal stage.

There is practically no noticeable growth in the adult stage. A small fly does not become a large fly, a small bee a large bee; the larval period only is the period of growth, the adult being the stage of reproduction.

There are two kinds of metamorphosis in insects, known as complete and incomplete metamorphosis. In the former, we have the egg, the active feeding larva, the quiescent pupa (the period of metamorphosis) and the active sexual adult. In the second, there is normally the egg, an active feeding nymph and then the adult—there is no complete change as in the former, but a gradual growth from the larva stage into the adult. Insects with complete metamorphosis are—beetles, ants, bees, wasps, butterflies, moths etc. Insects of incomplete metamorphosis are bergs, dragon flies, aphis, grasshoppers, locusts etc.

Insects may cause damage in all the three stages of their life-cycle in the larval, pupal and adult forms. However, those which undergo incomplete metamorphosis, such as aphids, are harmful in the pupal stage (nymph) only. The quiescent pupa of a moth or sawfly can do no harm. Generally speaking, it is the larval stage which is most harmful.

Insects can be classified into two principal groups according to their feeding habits ; (a) biting insects and (b) sucking insects.

The biting insects possess biting mouth parts, having jaws with which they chew leaves upon which they live. They are caterpillars, grubs, grasshoppers, bittles etc. The sucking insects have no biting jaws. They insert their beaks into the soft tissues of leaf, stem or fruit and suck the sap from those tissues. Aphis, lice, mite, thrips, mealy bug, red spider, vegetable bugs etc. are examples of sucking insects.

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Common Remedies:

Various remedies are now adopted to combat insects and other pests. These include clean cultivation whereby weeds and under-growths are removed, rotation of crops, proper cultivation of the soil, proper use of fertilizer, sowing of seeds from healthy stock, drainage and chemical insecticides which are substances or mixtures used to kill insects. Usually insecticides are divided into four categories—stomach poisons, contact poisons, fumigants and systemic insecticides.

A stomach poison, as the name implies, enters the digestive canal of the insect along with the food and when it is absorbed in the body, it kills the insect. Such insecticides are usually dusted or sprayed on plants' parts and can also be given in the form of poison baits. Only biting insects having chewing types of mouth parts are killed by stomach poisons. The sucking insects such as aphids, jassids, bugs etc. cannot be killed by this type of insecticides.

The contact poisons enter the insect body through the cuticle or may clog the breathing apertures or enter the respiratory system through it, thus causing toxic symptoms, suffocation and death. These are mainly used for insects with the sucking type of mouth parts.

Fumigants sold in solid, liquid or gaseous forms, depending on their chemical nature, when exposed to air or suitably treated, release gases deadly to insects. These are primarily used for fumigation of houses, godowns, grain bags and for control of rats and termites.

Systemic insecticides are those which can be absorbed by the plant through its roots or aerial parts and, on being taken up by sucking insects along with the cell sap they get killed.

The application of insecticides by dusting on is a remedy that is only successful if the foliage is first wetted so that the dust may stick. All such dusting should, therefore, be done in the early morning, while the plants are wet with dew. It is useless when showers of rain wash off the adhering dust, shortly after application.

As regards the application of liquids, the objects generally is to send the liquid insecticides in as fine a mist as possible, so that every part of the plant is thoroughly wetted by them. This is done by using considerable pressure, driving the liquid and with air through special nozzles, so that the particles are finely divided. Sprayers, syringe etc. are used for this purpose.

The following are some of the common insecticides:

(a) *Stomach poison*

(i) Paris green — 1 lb
Water — 50 gallon

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(ii) *Lead arsenate/calcium arsenate*

Lead arsenate— 1 lb

Water —50 gallon

It is better to add 4 lbs of lime in each case before use, so that the solution may not injure the leaves.

Borers are biting stomach poisons over the plant, if they once get into the trunk or stem of the plant, and in dealing with them, it is best to use systemic insecticides.

(iii) *Poisoned baits are also used in many cases*

A poison bait may be made of two tea-spoonful of treacle, one tea-spoonful of paris green and two table spoonful of water with sufficient bran to make a paste. This is very useful for cut worms working just at the surface of the soil. Another bait may be prepared of 2 oz. of Paris green or white arsenic, 3 oz. bran and 1 oz. salt. This should be dried, moistened with molasses and water, and spread out on eating ground. This is particularly useful for crickets.

(b) *Contact poisons*(i) *Kerosene Emulsion*

Soap.....1/2 lb.

Kerosene..2 gallons

Water (hot)..1 gallon

Soap should be dissolved first in hot water and then kerosene added to it, and the mixture then stirred for about half an hour. This should be diluted ten times with water at the time of spraying.

(ii) *Tobacco solution :*

Tobacco solution (tobacco decoction) is prepared by soaking 1 lb of tobacco waste in 1 gallon of water overnight and subsequently boiled for an hour. A half lb. of bar soap is dissolved in it and it is diluted with 6 to 8 parts of water and then used. To kill aphids and other soft bodied insects this home-made solution is very useful.

(iii) Ordinary phenyl or kerosinised water may be used to drive away the red and white ants and crickets.

(iv) Dusting with fresh lime may be useful in case of snails and bugs.

(v) Dusting with dry and powdered sulphur also controls many insects—specially spiders, mites, etc.

(vi) *BHC*—This insecticide is generally used as a 5% or 10% dust. It can be also used as 0.1% or 0.2% spray,



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(vii) *DDI*—It is used generally as 5% dust and as spray containing 0.1% to 0.2%.

In using an insecticide for the first time, it is advisable to try it on one or two plants only. If the preparation is too strong, it will be reflected in the condition of the plant within 24 hours; thus a little caution may prevent a great loss. It is a good rule to employ the insecticide in a rather weak state until experience has been gained.

The following remedies should also be remembered :

(1) Hand-picking should always be resorted to. It is best for the caterpillars, snails, bugs, etc.

(2) Burning out the web-worms ; this is useful in case of leaf-miners and leaf-rollers.

(3) Cutting off the branches and burning them—particularly in case of hole borers, or where the galls and deformities are formed.

(4) Flooding is useful in cases of crickets and for insects which hives in the soil.

(5) Use a light trap especially for night flying insects. Many insects are attracted by lights. A light placed in the centre of a bowl of water with castor oil in it will be useful in this connection.